US Army Corps of Engineers
Philadelphia District

New Jersey Department of Environmental Protection

Barnegat Bay Ecosystem Restoration Feasibility Study

Draft Report

Volume 1

Feasibility Report
Integrated Environmental Assessment

October 2003

Barnegat Bay Ecosystem Restoration Feasibility Report
& Integrated Environmental Assessment

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*Indicates information required for National Environmental Policy Act compliance

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List of Acronyms

AMA	Andrews, Miller and Associates, Inc.
BBEP	Barnegat Bay Estuary Program
CCMP	Comprehensive Conservation and Management Plan
CE/ICA	Cost Effectiveness/Incremental Cost Analysis
CERCLA	Comprehensive Environmental Response, Compensation, and Liability Act
CMP	Corrugated Metal Pipe
CMPA	Corrugated Metal Pipe Arch
EA	Environmental Assessment
EC	Engineering Circular
EDR	Environmental Data Resources
EFH	Essential Fish Habitat
ER	Engineering Regulation
GIS	Geographic Information System
HEP	Habitat Evaluation Procedure
HIS	Habitat Suitability Index
HTRW	Hazardous, Toxic and Radioactive Wastes
IWR	Institute for Water Resources
LBI	Long Beach Island
LERRD	Lands, Easements, Rights-of-Ways, Relocations and Dredged Material Disposal Areas
MCACES	Micro Computer Assisted Cost Estimating System
MLW	Mean Low Water

NAVD	North American Vertical Datum of 1988
NEP	National Estuary Program
NEPA	National Environmental Policy Act
NER	National Ecosystem Restoration (Plan)
NJ SHPO	New Jersey State Historic Preservation Office
NJDPE	New Jersey Department of Environmental Protection
NMFS	National Marine Fisheries Service
OMRR&R	Operation, Maintenance, Repair, Replacement and Rehabilitation
PCA	Project Cooperation Agreement
RCRA	Resource Conservation and Recovery Act
SAV	Submerged Aquatic Vegetation
USACE	United States Army Corps of Engineers
USEPA	United States Environmental Protection Agency
USFWS	United States Fish and Wildlife Service
USGS	United States Geologic Survey
WMA	Wildlife Management Area
WRDA	Water Resources Development Act

BARNEGAT BAY ECOSYSTEM RESTORATION FEASIBILITY STUDY
Feasibility Report and Integrated Environmental Assessment

EXECUTIVE SUMMARY

Proposed Action:	Ecosystem restoration at six locations in and adjacent to Barnegat Bay.
Locations of Actions:	Brick Township, Berkeley Township, Lacey Township, Long Beach Township, Eagleswood Township, and Little Egg Harbor Township, Ocean County, New Jersey.
Type of Statement:	Feasibility Study and Integrated Environmental Assessment
Lead Agency:	U.S. Army Corps of Engineers, Philadelphia District
Study Sponsor:	New Jersey Department of Environmental Protection
More Information:	For further information please contact: Minas Arabatzis, Chief, Planning Division Attn: Terry Fowler, Coastal Planning Section U.S. Army Corps of Engineers Philadelphia District Wanamaker Building, 100 Penn Square East Philadelphia, PA 19107-3390 Telephone: (215) 656-6575

Executive Summary

This report presents the results of a feasibility phase study and integrated Environmental Assessment (EA) to determine implementable solutions and the extent of Federal participation for projects that provide ecosystem restoration in Barnegat Bay, Ocean County, New Jersey. The purpose of the EA is to evaluate anticipated environmental impacts of the alternatives with emphasis on the selected plans for each proposed site.

The Barnegat Bay Ecosystem Restoration Feasibility Study was authorized by a resolution adopted by the U.S. House of Representatives in September 1995. This feasibility study was cost-shared between the Federal Government and the State of New Jersey, through the New Jersey Department of Environmental Protection (NJDEP), and was conducted under the provisions of the Feasibility Cost Sharing Agreement executed 26 August 1998. This feasibility study was initiated on that date.

The four proposed restoration project sites are located in Barnegat Bay, Ocean County, New Jersey, in the southeastern part of the State. (Six sites were studied in-depth during the feasibility study. However, per the December 19, 2002 request of the landowner, the Bayville Abandoned Lagoon site is not being recommended for restoration. In addition, United States Army Corps of Engineers (USACE) Headquarters has determined that the results of the current investigation indicate that it is appropriate for the United States Fish and Wildlife Service (USFWS), rather than USACE, to implement the F & L Lagoons project.) The Barnegat Bay estuarine ecosystem, located between the Atlantic coastal barrier islands and the New Jersey mainland, consists of two hydrologically connected bays, Barnegat Bay and Little Egg Harbor. For the purposes of the feasibility study, the Barnegat Bay ecosystem is defined as Barnegat Bay itself and adjacent lands west to the area of the Garden State Parkway. This covers approximately 328-mi^2 (210,000 acres) of Ocean County, NJ stretching from Point Pleasant and Bay Head in the north to Beach Haven Inlet in the south, and from Island Beach and Long Beach Island in the east to the Garden State Parkway in the west (Kennish and Lutz 1984).

Over time human activity has resulted in ecosystem degradation and habitat loss for many species of wildlife in the estuary and watershed. In 1995 the U.S. Environmental Protection Agency recognized Barnegat Bay as an estuary of national significance and the Barnegat Bay Estuary Program (BBEP) was initiated to address the health of the estuary. In coordination with BBEP, the Barnegat Bay Ecosystem Restoration Feasibility Study conducted a site selection process, identified priority sites for immediate evaluation, and assessed various alternative plans of improvement based on ecosystem restoration benefits. Various alternative plans for each of the six proposed sites were identified and evaluated on the basis of their suitability, applicability, and merit in meeting the restorative objectives, planning constraints, economic criteria, environmental criteria, and social criteria for the study. The selected plans are as follows:

- F&L Abandoned Lagoon – The project site is located in Brick Township on the west side of the Bay, about 0.75 miles north of the Route 528 bridge to Mantoloking. The selected plan will provide a total of 8.45 acres of fish and benthic habitat and 3.27 acres of diamondback terrapin habitat through a combination of decreasing existing lagoon depths

to an average of 6 feet, thereby improving water quality and flattening/clearing existing sandy piles (for terrapin habitat). Circulation will be improved by excavating a 270-foot long channel of approximately 400 square feet in cross sectional area between the ends of the two prongs of F Lagoon, and two 200-foot long channels of approximately 400 square feet in cross sectional area between the ends of the two prongs of F Lagoon and L Lagoon. However, because the site is owned by a Federal agency (USFWS), USACE would need to demonstrate consistency with USACE ER 1105-2-100, Planning Guidance Notebook, Appendix F,b.1 prior to approval for construction.

- Bayville Abandoned Lagoon – The project site is located in Berkeley Township off the south side of Bayview Avenue east of Bayville, about 3,360 feet to the east of the intersection with Amherst Drive. Planning activities prior to December 19, 2002 indicate that the selected plan involves providing a total of 4.79 acres of fish and benthic and black duck habitat by decreasing existing lagoon depths to an average of 6 feet and improving water quality (by improving circulation and decreasing depth). Circulation will be improved by excavation of an approximately 500-foot long channel with 300 square feet in cross section area meandering through the phragmites and tidal marsh areas between the west end of the lagoon and the Bay; installation of up to three 64"x43" elliptical concrete or aluminum corrugated metal arch (CMPA) culvert pipes with end sections, 50-foot long each across the road, and a 250-foot long open channel with 70 square feet of cross sectional area below MLW and up to 130 square feet above MLW through a short segment of the upland forest and predominantly phragmites area further to the east end of the Lagoon and into the Bay. However, per request made by the landowner, the County of Ocean, on December 19, 2002, USACE recommends that work at this project site not be pursued beyond the feasibility phase.

- Oyster Creek – The project site is located in Lacey Township on the northern bank of Oyster Creek, at its confluence with Barnegat Bay. The selected plan will provide a total of 18.31 acres of salt marsh for birds and 10.14 acres of diamondback terrapin habitat. A meandering and braided open channel system will be excavated to approximately 35 feet in width at MLW and 9,400 feet in length, connecting to the Bay at the east and in the south through 100-foot wide openings provided through an existing timber bulkhead.

- Barnegat Lighthouse – The project site is located in Long Beach Township, in the Municipality of Barnegat Light, on the southern side of Barnegat Inlet, immediately southeast of Barnegat Lighthouse. The selected plan will provide 6.72 acres of piping plover habitat through excavation of a pond with a surface area of approximately 5 acres measured at MHW with access to tidal water landward of the Barnegat Inlet south jetty by means of two inlets formed by two open channels.

- Stafford Forge – The project site is located in Eagleswood and Little Egg Harbor Townships, about two miles north of the town of West Creek, on Westecunk Creek, to the immediate north of the Garden State Parkway. The selected plan will provide 70.86 acres of black duck habitat and 113.57 acres of on-site habitat for anadromous fish. In addition, approximately 10.2 stream miles will be made available to fish above the site.

A fish ladder will be added to an existing water control structure and existing culvert and water control structures will be refurbished or installed.

- Flat Island – The project site is located in Long Beach Township, in Barnegat Bay, approximately one mile southwest of Ship Bottom, Long Beach Island. The selected plan will provide 10.08 acres of salt marsh habitat for birds. A meandering and braided open channel system will be excavated through a portion of the western side of the island. The channel system will be approximately 10,000 feet in length with the average cross-section including 70 square feet below MLW and 130 square feet above MLW.

A Section 404(b)(1) evaluation has been prepared and is included in this Feasibility Study and Integrated Environmental Assessment. This evaluation concludes that the proposed action will not result in any significant environmental impacts relative to the areas of concern under Section 404 of the Federal Clean Water Act. The restorative nature of the proposed projects is expected to result in significant positive benefits to the natural resources of the Barnegat Bay ecosystem. As a result, it is not anticipated that any cumulative adverse impacts will occur.

The proposed actions involving excavation of clean fill may result in minor, temporary impacts to aquatic wildlife by temporarily increasing turbidity. No long-term negative impacts are anticipated to occur. Restoration efforts to less disturbed prior conditions will likely increase populations of fish, benthos, and birds by improving water quality and habitat. The proposed actions are anticipated to pose only minor, temporary impacts on terrestrial wildlife due to vegetation clearing. No adverse effects to adjacent mapped Essential Fish Habitat are anticipated. Use of construction equipment in the project area may cause a temporary increase in emissions of volatile organic compounds, nitrogen oxides, sulfur dioxide, and carbon monoxide. Emissions produced during the construction period are not expected to exceed ambient air quality standards for the area. No long-term impacts to local air quality are expected from the proposed actions; therefore no adverse effects are anticipated. It is not anticipated that any hazardous materials will be encountered at any of the proposed project sites or directly adjacent properties. Impacts to existing wetlands have been minimized by careful selection of proposed channel excavation. The outcome will be improved water circulation within degraded wetland habitats.

This Feasibility Study and Integrated Environmental Assessment is being coordinated with the U.S. Environmental Protection Agency, the U.S. Fish and Wildlife Service, the National Marine Fisheries Service, and the New Jersey Department of Environmental Protection. The Environmental Assessment has determined that the proposed activities are not likely to jeopardize the continued existence of any species or the critical habitat of any fish, wildlife, or plant that is designated as endangered or threatened, pursuant to the Endangered Species Act of 1973as amended by P.L. 96-159.

A Section 401 Water Quality Certificate and a Coastal Zone Consistency Determination will be obtained from the New Jersey Department of Environmental Protection prior to project construction.

With the exception of Stafford Forge, there are no known properties listed on, or eligible for listing on, the National Register of Historic Places that would be adversely affected by the proposed project plans. The proposed project will avoid areas suspected of containing archaeologically sensitive sites and is therefore not expected to impact any cultural resources. Additional research is required at Stafford Forge to provide a history of the cranberry operation at the site and to determine the age and condition of related structural features in order to evaluate National Register eligibility.

Initial project costs are as follows. Lands, Easements, Rights-of-Ways, Relocations and Dredged Material Disposal Areas (LERRD) costs will be credited toward the non-Federal sponsor's cash contribution.

- F&L Abandoned Lagoons - Based on January 2002 price levels, the total project cost is estimated to be $1,115,989. The Federal share of this cost is $725,393 and the non-Federal share is $390,596. LERRD costs are $7,015 and will be credited toward the non-Federal sponsor's cash contribution. However, because the site is owned by a Federal agency (USFWS), USACE would need to demonstrate consistency with USACE ER 1105-2-100, Planning Guidance Notebook, Appendix F,b.1 prior to approval for construction.

- Bayville Abandoned Lagoon - Based on January 2002 price levels, the total project cost is estimated to be $958,310. The Federal share of this cost is $622,902 and the non-Federal share is $335,408. LERRD costs are $15,295. However, per request made by the landowner, the County of Ocean, on December 19, 2002, USACE recommends that work at this project site not be pursued beyond the feasibility phase.

- Oyster Creek - Based on January 2002 price levels, the total project cost is estimated to be $2,210,952. The Federal share of this cost is $1,437,119 and the non-Federal share is $773,833. LERRD costs are $59,930.

- Barnegat Lighthouse - Based on January 2002 price levels, the total project cost is estimated to be $2,257,173. The Federal share of this cost is $1,467,162 and the non-Federal share is $790,011. LERRD costs are $9,787.

- Stafford Forge - Based on January 2002 price levels, the total project cost is estimated to be $480,662. The Federal share of this cost is $312,430 and the non-Federal share is $168,232. LERRD costs are $8,050.

- Flat Island - Based on January 2002 price levels, the total project cost is estimated to be $2,263,555. The Federal share of this cost is $1,471,311 and the non-Federal share is $792,244. LERRD costs are $63,423.

- Total of All Projects - Based on January 2002 price levels, the total project cost is estimated to be $9,286,641. The Federal share of this cost is $6,036,317 and the non-Federal share is $3,250,324. LERRD costs are $163,500.

Ultimate project costs are as follows. All costs include planning, engineering, and design. Operation, Maintenance, Repair, Replacement, and Rehabilitation (OMRR&R) is a non-Federal responsibility.

- F&L Abandoned Lagoon - The ultimate cost of construction which includes initial construction and project monitoring is estimated to be $1,127,149, cost shared 65% Federal, 35% non-Federal. However, because the site is owned by a Federal agency (USFWS), USACE would need to demonstrate consistency with USACE ER 1105-2-100, Planning Guidance Notebook, Appendix F,b.1 prior to approval for construction.

- Bayville Abandoned Lagoon - The ultimate cost of construction which includes initial construction and project monitoring is estimated to be $967,893, cost shared 65% Federal, 35% non-Federal. However, per request made by the landowner, the County of Ocean, on December 19, 2002, USACE recommends that work at this project site not be pursued beyond the feasibility phase.

- Oyster Creek - The ultimate cost of construction which includes initial construction and project monitoring is estimated to be $2,233,062, cost shared 65% Federal, 35% non-Federal.

- Barnegat Lighthouse - The ultimate cost of construction which includes initial construction and project monitoring is estimated to be $2,279,745, cost shared 65% Federal, 35% non-Federal.

- Stafford Forge - The ultimate cost of construction which includes initial construction, archeological salvage and project monitoring is estimated to be $505,469, cost shared 65% Federal, 35% non-Federal.

- Flat Island - The ultimate cost of construction which includes initial construction and project monitoring is estimated to be $2,286,191, cost shared 65% Federal, 35% non-Federal.

- Total of All Projects - The ultimate cost of construction which includes initial construction, archeological salvage and project monitoring is estimated to be $9,399,509, cost shared 65% Federal, 35% non-Federal.

DRAFT
FINDING OF NO SIGNIFICANT IMPACT

BARNEGAT BAY ECOSYSTEM RESTORATION
OCEAN COUNTY, NEW JERSEY

BACKGROUND

This Environmental Assessment was prepared as part of the feasibility study for the Barnegat Bay Ecosystem Restoration. The study was the result of a resolution of the Committee on Transportation and Infrastructure of the U.S. House of Representatives, in Docket 2462 adopted on September 15, 1995. The committee requested that the U.S. Army Corps of Engineers conduct a study of the Barnegat Bay estuary and surrounding areas to identify and recommend improvements in the areas of ecosystem restoration and protection.

The Barnegat Bay estuarine ecosystem, located between the Atlantic coastal barrier islands and the New Jersey mainland, consists of two hydrologically connected bays, Barnegat Bay and Little Egg Harbor. For the purposes of the feasibility study, the Barnegat Bay ecosystem is defined as Barnegat Bay itself and adjacent lands west to the area of the Garden State Parkway. This covers approximately 328-mi2 (210,000 acres) of Ocean County, NJ stretching from Point Pleasant and Bay Head in the north to Beach Haven Inlet in the south, and from Island Beach and Long Beach Island in the east to the Garden State Parkway in the west.

PURPOSE

The purpose of this study was to determine the feasibility of addressing the following problems (and associated objectives) for the Barnegat Bay ecosystem identified in the reconnaissance study: (1) ecosystem degradation and habitat loss (including freshwater wetlands restoration/creation, salt marsh restoration, restoration of abandoned lagoons, and submerged aquatic vegetation (SAV) restoration) and (2) fish and wildlife ecosystem degradation (including restoration of fishery habitat, waterbird habitat restoration, and creation/restoration of islands). Specifically, this feasibility study completed the problem identification, plan formulation, and environmental assessment phases associated with the proposed action (six restoration projects and their alternatives).

PROPOSED ACTION

The six restoration projects included in the proposed action are (1) lagoon and water quality improvements to restore fish, benthic invertebrate, and terrapin habitat in F&L Abandoned Lagoons; (2) lagoon and water quality improvements to restore fish, benthic invertebrate, and waterfowl habitat in Bayville Abandoned Lagoon; (3) tidal marsh and terrapin habitat restoration in Oyster Creek; (4) creation of intertidal feeding habitat for the Federal threatened and state endangered piping plover in Barnegat Lighthouse; (5) reintroduction of river herring and American eel fisheries, along with waterfowl improvements, in Stafford Forge; and (6) tidal

marsh restoration in Flat Island. These projects primarily involve physical alteration of the environment to restore components of ecosystems (i.e., their structure and function), and are described as changes in habitat type and/or quality. Other management measures relevant to each restoration project but outside the purview of the Corps (e.g., control of nonpoint source pollution, reducing human recreational activity) are not included in the restoration objectives but may be carried out by the appropriate agencies. Each restoration was planned for a project life of 25 years, with the exception of Barnegat Lighthouse, which was planned for 10 years. Critical to the implementation of these planning objectives are each restoration project's specifications for increasing habitat units representative of more natural, high ecological integrity conditions, as derived from habitat preferences for selected representative species or suites of species. The calculation of projected habitat units for each restoration project alternative was the basis of plan selection.

General, economic, and environmental criteria were used to evaluate alternative restoration designs for each project. Specifically, environmental criteria were applied to each alternative to ensure that any adverse environmental effects that might arise from implementing the projects will be avoided or minimized. Specifically, best management practices will be employed during all project construction, including (1) minimization of activity outside the project footprint, (2) use of sediment fences to control runoff, (3) restriction of construction during critical habitat use periods, and (4) design features to preserve existing valuable habitat. The environmental evaluation was coordinated with the U.S. Environmental Protection Agency, the U.S. Fish and Wildlife Service, the National Marine Fisheries Service, the New Jersey Department of Environmental Protection, the New Jersey State Historic Preservation Office, and all other known interested parties.

ENVIRONMENTAL CONSEQUENCES

The Environmental Assessment has determined that the proposed action is not likely to result in significant adverse impacts to any resource. It is expected that the proposed action will result in significant positive benefits to the natural resources of Barnegat Bay ecosystem.

The proposed action is not likely to jeopardize the continued existence of any species or the critical habitat of any fish, wildlife, or plant that is designated as endangered or threatened, pursuant to the Endangered Species Act of 1973 as amended by P.L. 96-159.

A Section 401 Water Quality Certificate and a Coastal Zone Consistency Determination will be obtained from the New Jersey Department of Environmental Protection for the proposed project.

There are historic properties that may be eligible for listing on the National Register of Historic Places that could be adversely affected by the proposed project. However, measures can be taken to avoid these impacts. Consultation with the New Jersey State Historic Preservation Office to identify and avoid these impacts is ongoing and will be concluded prior to project construction.

RECOMMENDATION

Because the Final Environmental Assessment concludes that the proposed project is not a major Federal action significantly affecting the human environment, I have determined that an Environmental Impact Statement is not required.

_____ _____

Thomas C. Chapman, P.E. Date
Lieutenant Colonel, Corps of Engineers
District Engineer

COMPLIANCE TABLE

Compliance of the Proposed Action with Other Environmental Protection Statutes and Other Environmental Requirements

FEDERAL STATUTES	LEVEL OF COMPLIANCE
Anadromous Fish Conservation Act	Full
Archaeological Resources Protection Act	Ongoing
Clean Air Act	Full
Clean Water Act	Ongoing
Coastal Barrier Resources Act	Full
Coastal Zone Management Act	Ongoing
Comprehensive Environmental Response, Compensation and Liability Act	N/A
Endangered Species Act	Full
Estuary Protection Act	Full
Federal Water Project Recreation Act	Full
Fish and Wildlife Coordination Act	Ongoing
Land and Water Conservation Fund Act	Full
Magnuson-Stevenson Act – Essential Fish Habitat	Full
Marine Mammal Protection Act	Full
Marine Protection, Research and Sanctuaries Act	Full
National Historic Preservation Act	Ongoing
National Environmental Policy Act	Ongoing
Rivers and Harbors Act	Full
Watershed Protection and Flood Prevention Act	Full
Wild and Scenic Rivers Act	N/A
EXECUTIVE ORDERS (EOS), MEMORANDUMS, ETC.	
EO 11593 Protection and Enhancement of Cultural Environment	Full
EO 11988 Floodplain Management	Full
EO 11990 Protection of Wetlands	Full
EO 12114 Environmental Effects of Major Federal Actions	Full
EO 12989 Environmental Justice	Full

Note:
Full Compliance – Having met all requirements of the statute, EO, or other environmental requirements for the current stage of planning.
Partial Compliance – Not having met some of the requirements that are normally met in the current stage of planning.
Ongoing – Coordination is continuing. All applicable laws and regulations will be fully complied with before any work is done, including obtaining State Water Quality Certification, approval from the State Historic Preservation Officer, and Coastal Zone Management Determination.

N/A – Not applicable. There are no requirements for the statute, EO, or other environmental requirement for the current stage of planning.

1.0 INTRODUCTION

Barnegat Bay is a 75- mi^2 estuary draining a 660-mi^2 watershed located primarily within Ocean County, New Jersey. Since the early 1900s, the estuary has been impacted by various human activities, resulting in the loss of habitat from filling and dredging activities, loss of habitat from hydrological modifications, invasion of habitats by invasive plants, and degradation of water quality. Identification of ecosystem restoration problems, needs, and opportunities for Barnegat Bay began with the Congressional resolution on Barnegat Bay, NJ (September 14, 1995), charging the United States Army Corps of Engineers (USACE), Philadelphia District, with completing an expedited reconnaissance study to identify possible improvements in ecosystem restoration and protection. Following that reconnaissance study, the USACE undertook the feasibility study described herein.

1.1 PURPOSE AND SCOPE

The purpose of a feasibility study is to ensure the timely and economical completion of a quality feasibility report that is expected to recommend an implementable solution to the identified problems.

This feasibility report presents the results of a feasibility level study and will accomplish the following:

a. Provide a complete presentation of study results and findings so that readers can reach independent conclusions regarding the reasonableness of recommendations.

b. Indicate compliance with applicable statutes, executive orders and policies.

c. Provide a sound and documented basis for decision makers at all levels to judge the recommended solutions.

This report documents the analysis of existing conditions, without project conditions, plan formulation, and project designs in order to provide ecosystem restoration for specific areas within, or adjacent to, Barnegat Bay. The evaluations were based on site-specific technical information developed during the course of the study.

This feasibility report will detail the following for each study area:

a. Define problems and opportunities

b. Identify potential solutions

c. Identify costs, benefits, environmental and social impacts of potential solutions

d. Present the selected plan for each site

e. Present the Project Cooperation Agreement (PCA) responsibilities of the non-Federal sponsor

This study is being conducted in accordance with all applicable guidance, including ER 1105-2-100, Planning Guidance Notebook (Revised, 22 April 2000). To provide full and convenient access to the environmental, economic and engineering documentation prepared for the study, the Environmental Assessment (EA) for this project has been integrated into this feasibility report in accordance with the above referenced regulation. Sections required for compliance with the National Environmental Policy Act (NEPA) are noted by an asterisk (*) in the Table of Contents.

1.2 AUTHORIZATION

The Barnegat Bay Ecosystem Restoration Study was authorized by Congressional resolution. Committee on Transportation and Infrastructure of the U.S. House of Representatives, Docket 2462, September 14, 1995 states:

> *Resolved by the Committee on Transportation and Infrastructure of the United States House of Representatives, that, the Secretary of the Army is requested to review the report of the Chief of Engineers on the Barnegat Inlet, New Jersey, published as House Document 358, and any other pertinent reports, with a view to determining whether modifications of the recommendations contained therein are advisable in the interest of comprehensive water resources management. This will include a study of the Barnegat Bay estuary and surrounding areas for identifying possible improvements in the areas of ecosystem restoration and protection including wetlands and aquatic vegetation; erosion, shore protection, and flood control; water related infrastructure; water supply; recreation; navigation and related dredged material management; water quality control regardless of drainage area, including circulation and point and non-point discharges; integration of watershed planning, construction and regulatory actions; and other related purposes.*

1.3 GENERAL DESCRIPTION OF STUDY AREA

The proposed projects are located in Barnegat Bay, Ocean County, New Jersey, in the southeastern part of the State. The Barnegat Bay estuarine ecosystem, located between the Atlantic coastal barrier islands and the New Jersey mainland, consists of two hydrologically connected bays, Barnegat Bay and Little Egg Harbor. For the purposes of the feasibility study, the Barnegat Bay ecosystem is defined as Barnegat Bay itself and adjacent lands west to the area of the Garden State Parkway (Figure 1-1). This covers approximately 328-mi^2 (210,000 acres) of Ocean County, NJ stretching from Point Pleasant and Bay Head in the north to Beach Haven Inlet in the south, and from Island Beach and Long Beach Island in the east to the Garden State Parkway in the west (Kennish and Lutz 1984). Figure 1-2 shows the locations of the six proposed projects within the study area. These projects are located over a 40-mile stretch of the

ecosystem that reaches from approximately 40 miles south of New York City to 20 miles north of Atlantic City, the closest urban center.

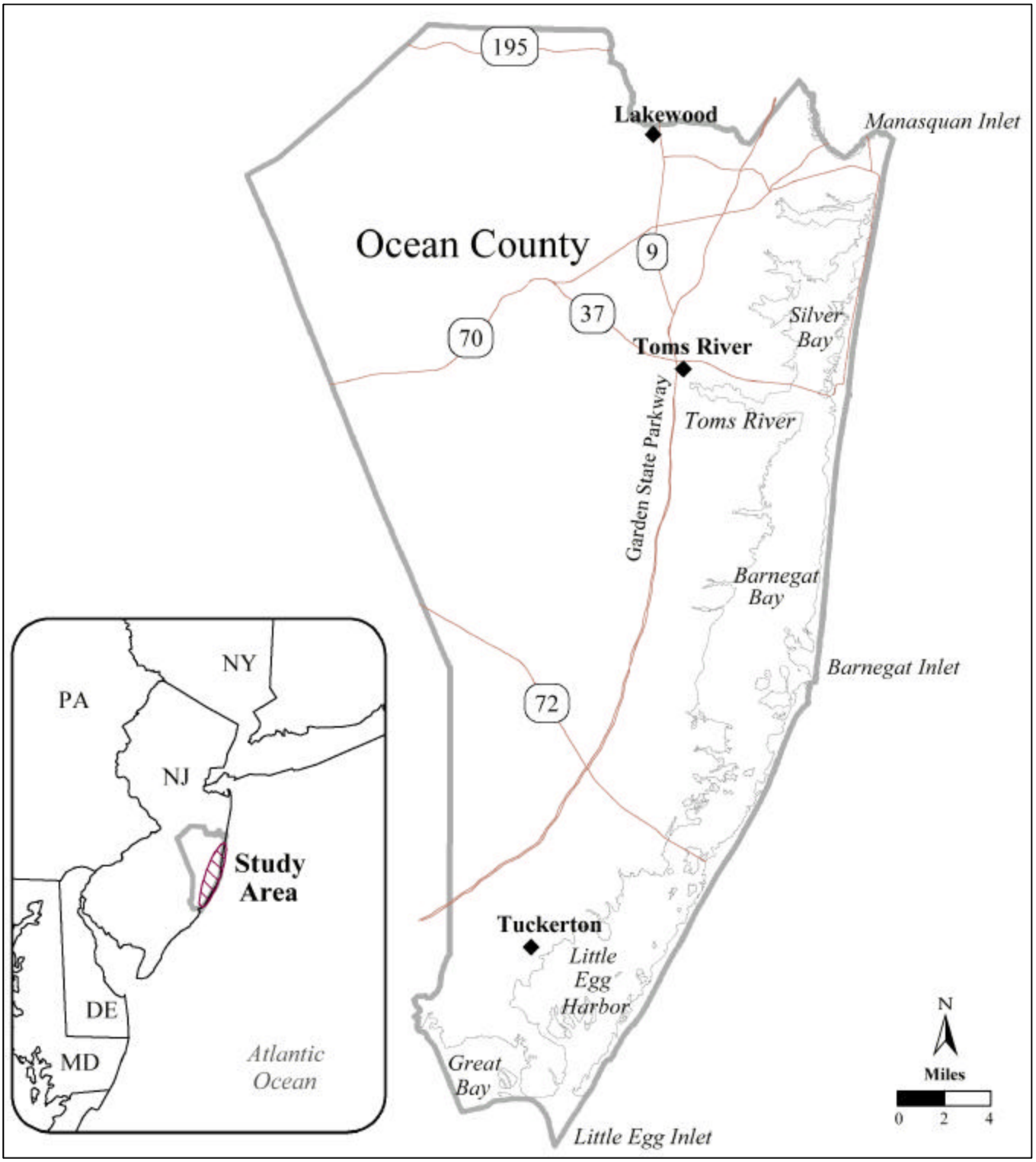


Figure 1-1 Location of the Barnegat Bay Ecosystem Site Selection study area within Ocean County, New Jersey.

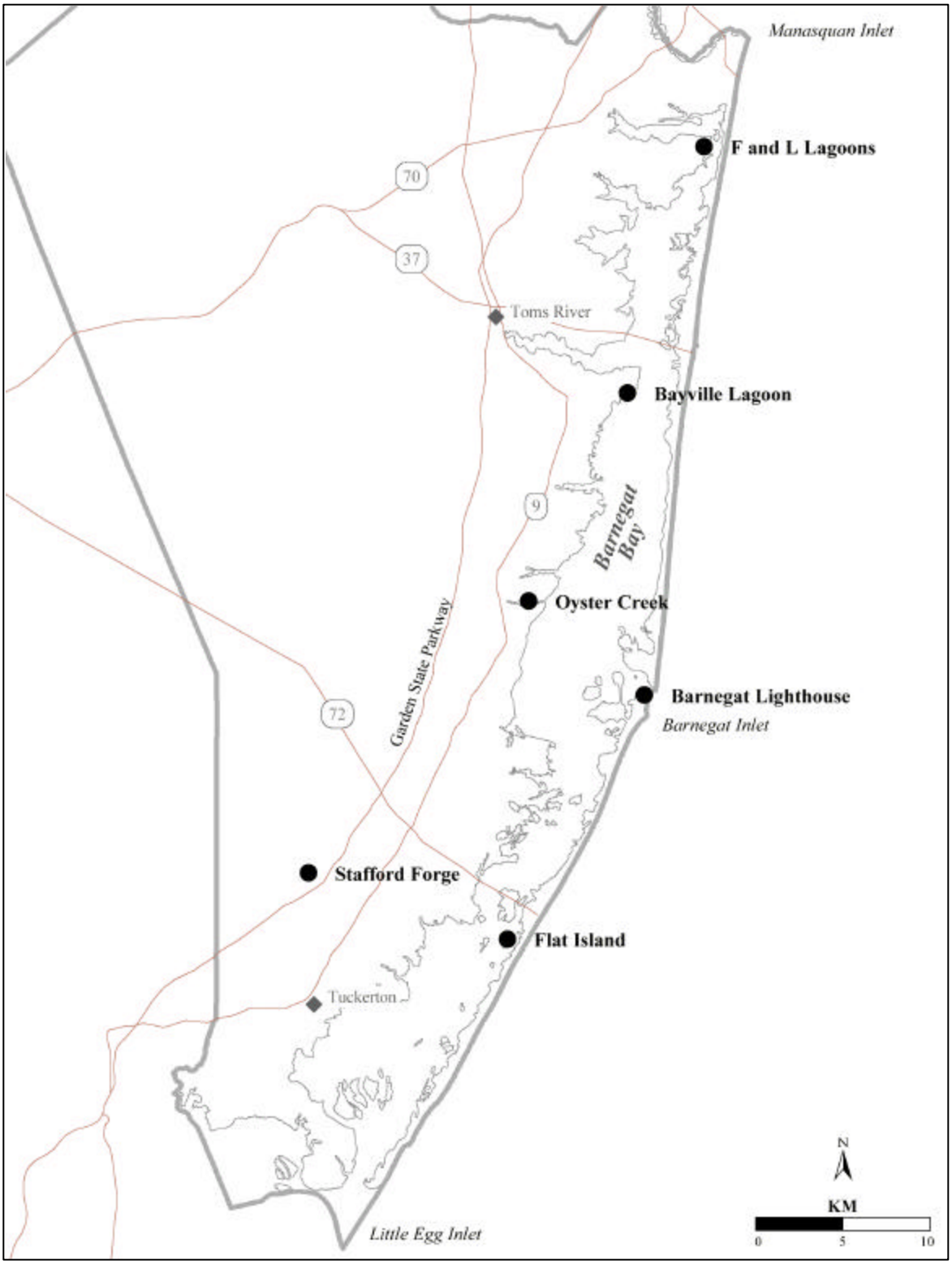


Figure 1-2 Locations of the six proposed restoration projects located throughout the Barnegat Bay ecosystem.

The six proposed restoration projects are located throughout the Barnegat Bay ecosystem. The F&L Abandoned Lagoons are located in West Mantoloking just south of Herring Island between the mouth of Metedeconk River and Route 528 (Mantoloking Road) (Figure 1-3). The Bayville Abandoned Lagoon is located east of Bayville, off the south side of Bayview Avenue, about 3,360 feet to the east of the intersection with Amherst Drive (Figure 1-4). Oyster Creek is located 1.37 miles east of the Oyster Creek Nuclear Generating Station, on the left bank of Oyster Creek at its confluence with Barnegat Bay (Figure 1-5). Barnegat Lighthouse is located within Barnegat Lighthouse State Park, just south of the Barnegat Inlet (Figure 1-6). Stafford Forge is located within the Stafford Forge Wildlife Management Area on Westecunk Creek, about two miles north of West Creek, and immediately north of the Garden State Parkway (Figure 1-7). Flat Island is located in Barnegat Bay, approximately one mile southwest of Ship Bottom, Long Beach Island (Figure 1-8).

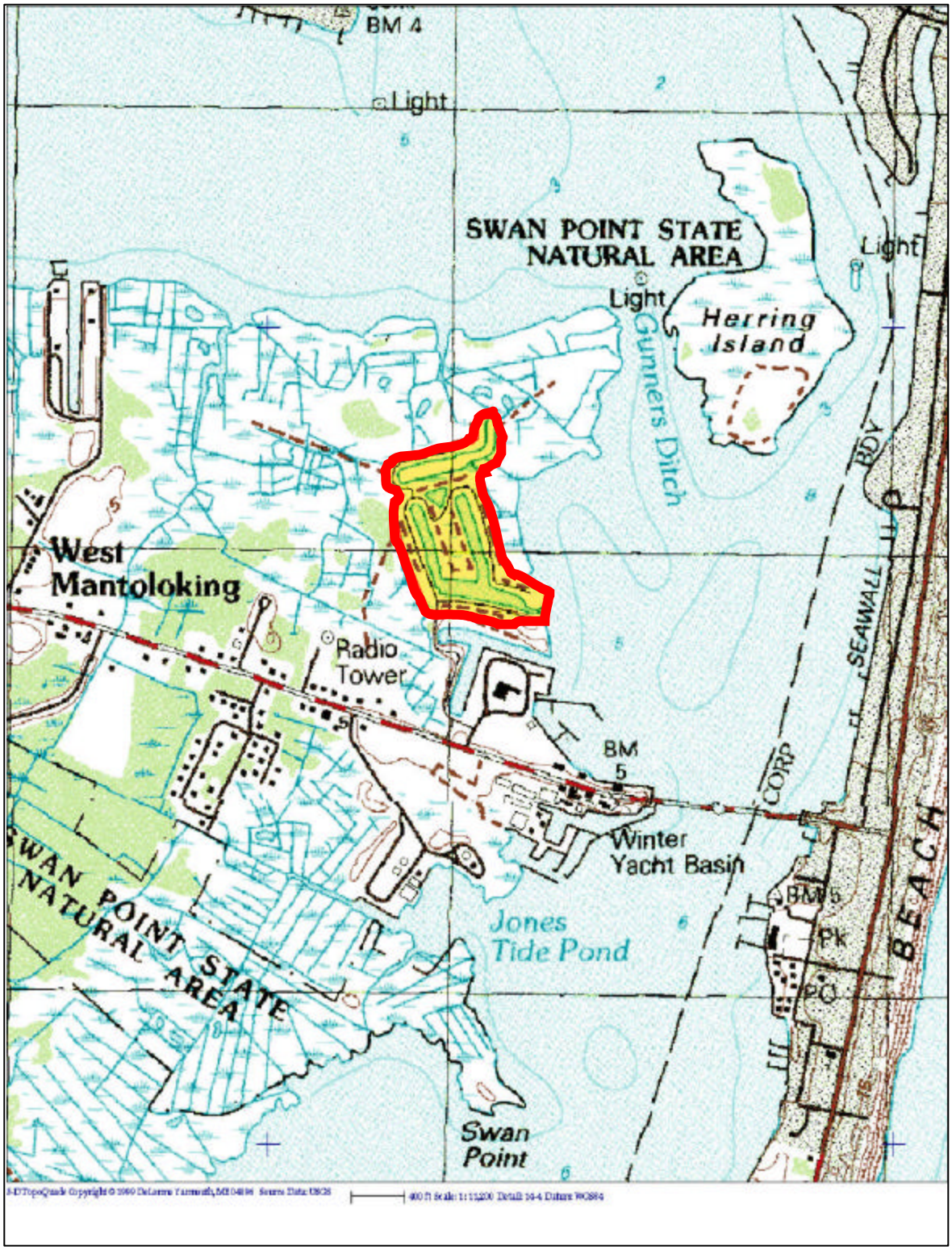


Figure 1-3 F&L Abandoned Lagoons located in West Mantoloking just south of Herring Island between the mouth of Metedeconk River and Route 528.

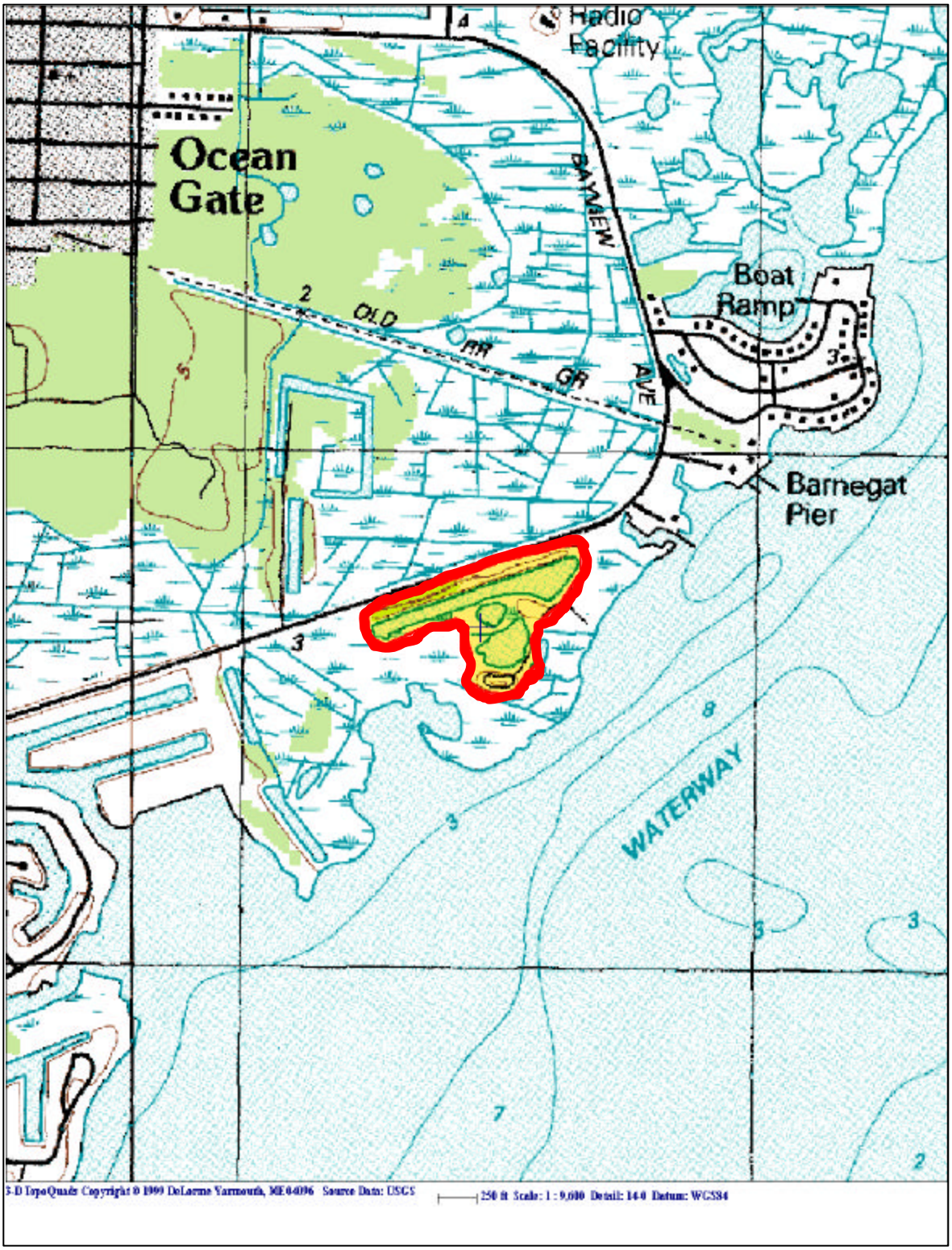


Figure 1-4 The Bayville Abandoned Lagoon located east of Bayville, off the south side of Bayview Avenue, about 3,360 feet to the east of the intersection with Amherst Drive.

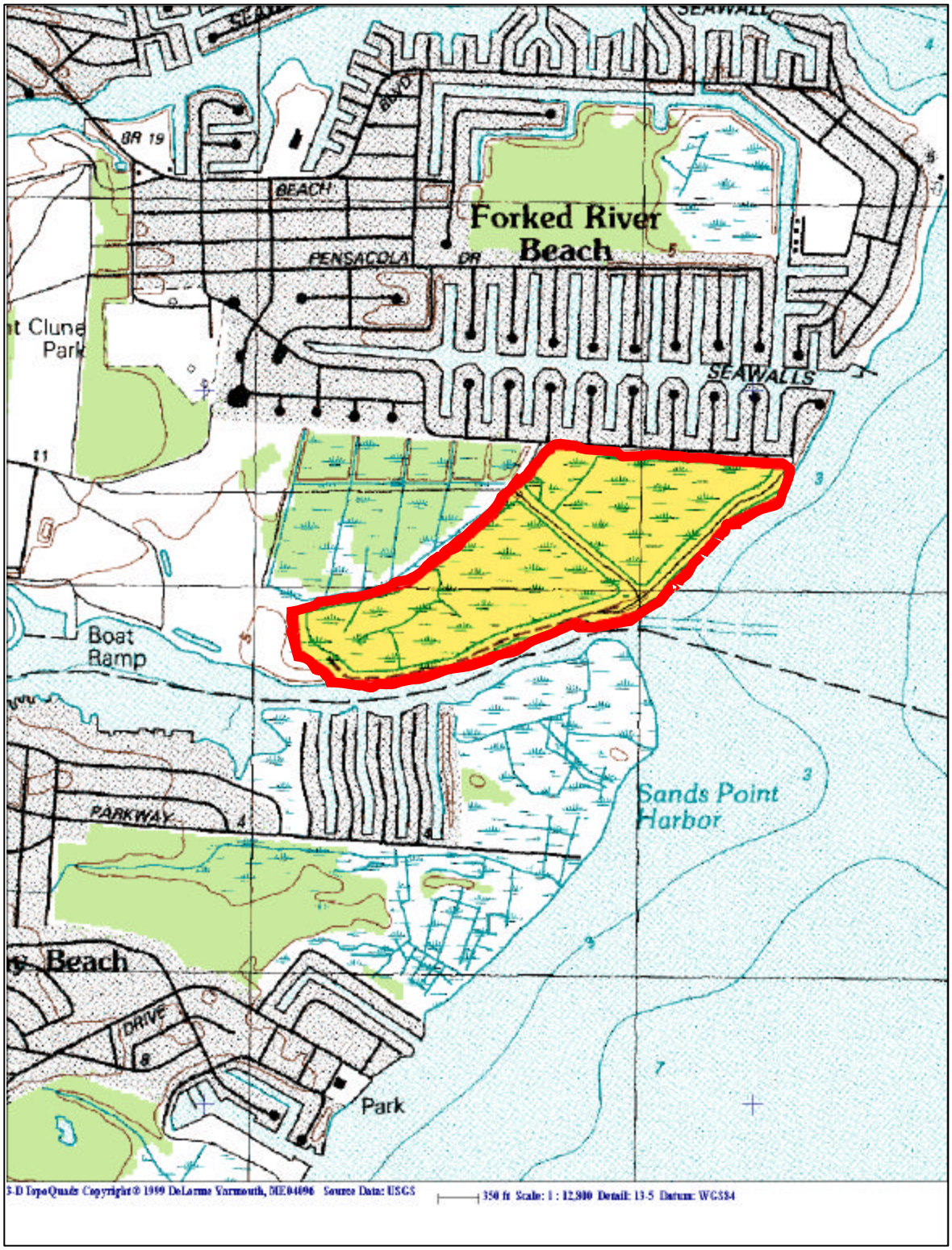


Figure 1-5 Oyster Creek located 1.37 miles east of the Oyster Creek Nuclear Generating Station, on the left bank of Oyster Creek at its confluence with Barnegat Bay.

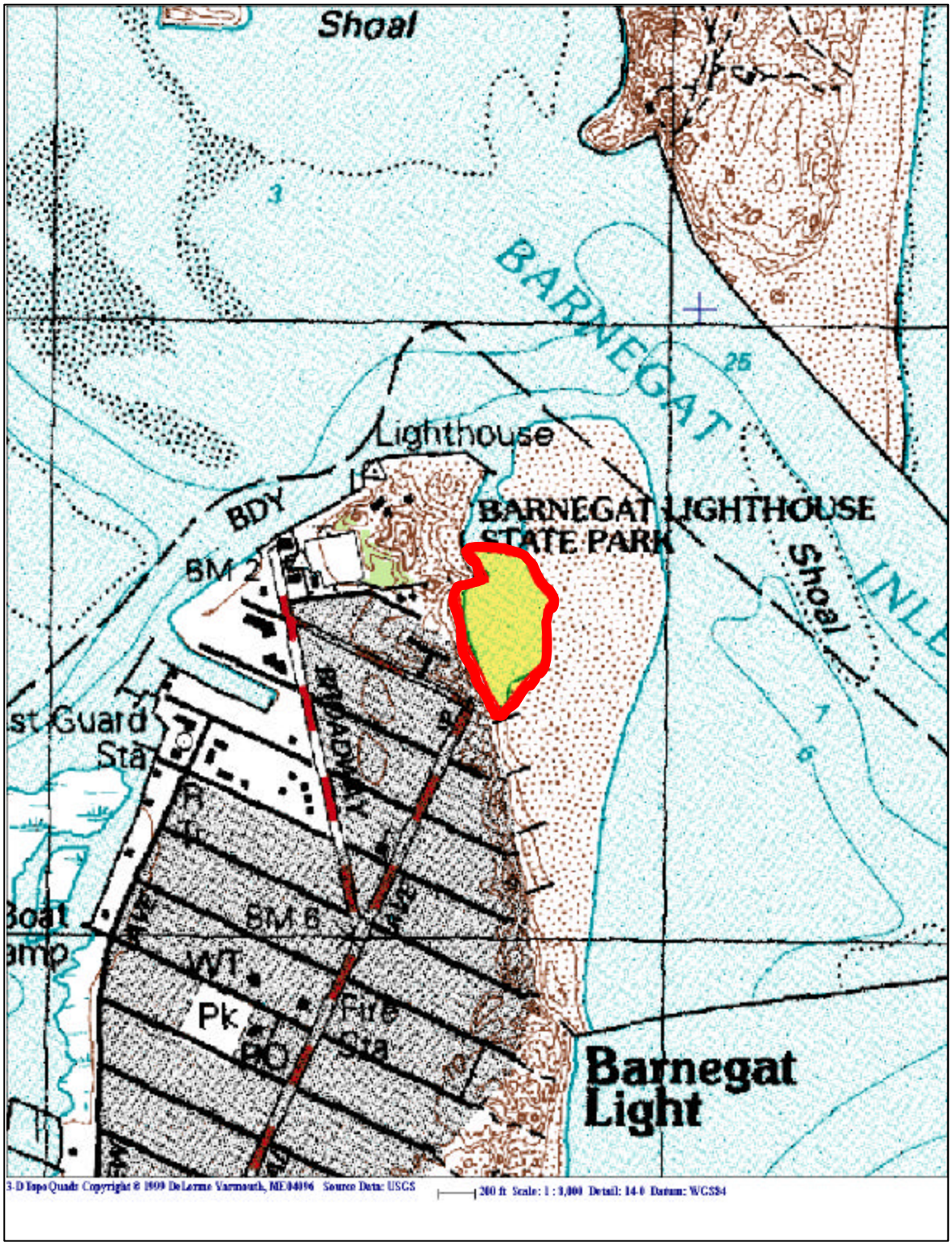


Figure 1-6 Barnegat Lighthouse located within Barnegat Lighthouse State Park,just south of the Barnegat Inlet.

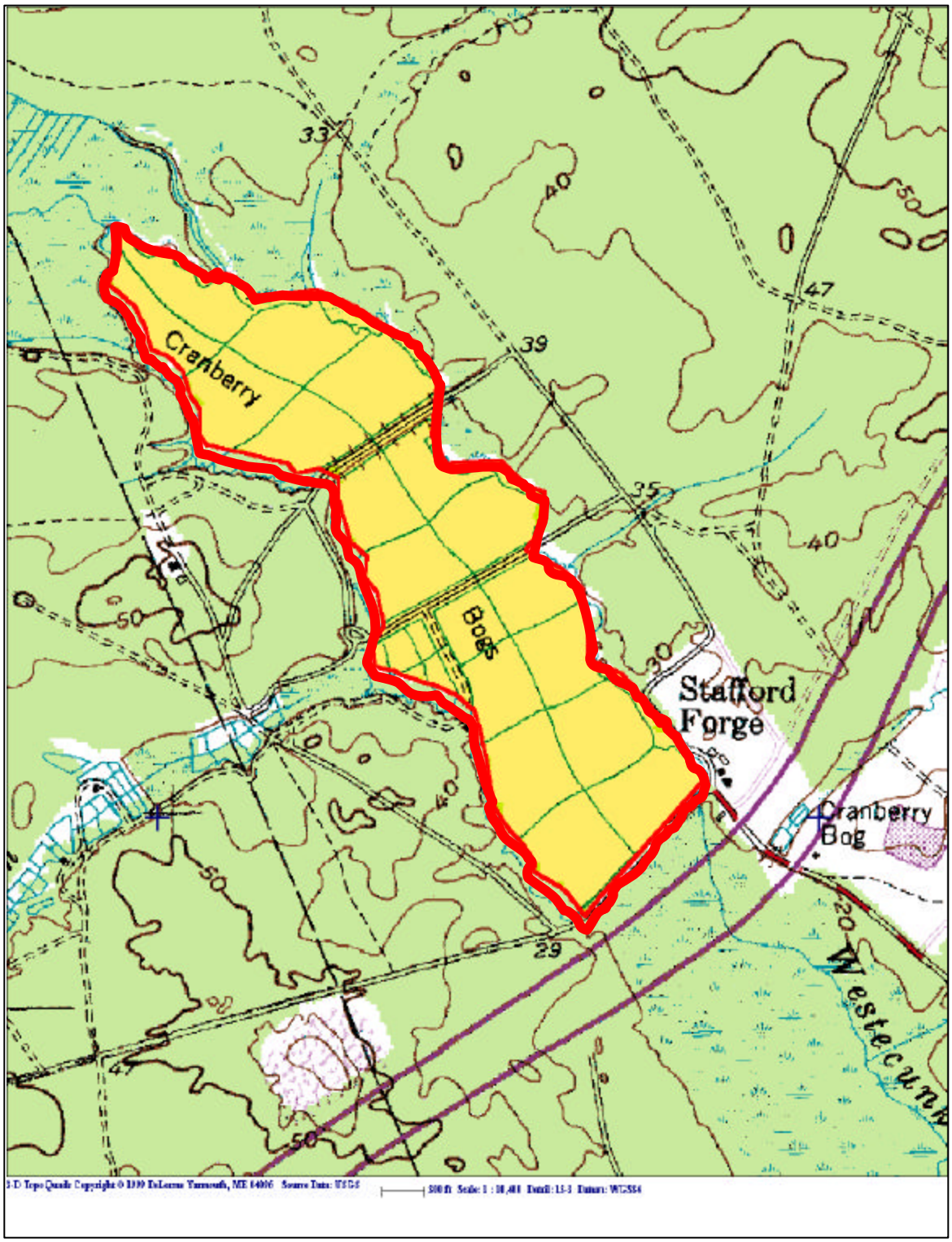


Figure 1-7 Stafford Forge located within the Stafford Forge Wildlife Management Area on Westecunk Creek, about two miles north of West Creek, and immediately north of the Garden State Parkway.

Figure 1-8 Flat Island located in Barnegat Bay, approximately one mile southwest of Ship Bottom, Long Beach Island.

2.0 PROJECT HISTORY

2.1 PRIOR STUDIES, REPORTS AND RELATED PROJECTS

There are numerous published and unpublished reports by USACE regarding the Barnegat Bay study area and adjacent locations. Applicable reports are listed in chronological order in Table 2-1.

Table 2-1

Prior Reports

	Title	Locality	Date	Description
1	House Document 646-61: Double Creek, New Jersey Navigation Project	Double Creek, NJ	1912	Construction of a navigation channel and associated features
2	Rivers and Harbors Committee, Document 73-19: Barnegat Inlet Navigation Project	Barnegat Inlet, NJ	1933	Authorized construction of navigation channel and two converging stone jetties
3	Manasquan Inlet Jetties (New Jersey Intracoastal Waterway)	Manasquan Inlet, NJ	1933	Construction of stabilized navigation channel and two parallel stone jetties
4	Rivers and Harbors Committee, Document 74-85: Barnegat Inlet Navigation Project	Barnegat Inlet, NJ	1936	Modification of Document 73-19
5	Barnegat Inlet Navigation Project: Construction of 180' timber and stone groin	Barnegat Inlet, NJ	1938	Located 170' west of Barnegat Lighthouse
6	Barnegat Inlet Navigation Project: Construction of navigation channel and stone jetties	Barnegat Inlet, NJ	1939-1940	Construction of project Authorized in 1933/1936
7	House Document 86-208: Shore of New Jersey – Barnegat Inlet to Cape May Canal, Beach Erosion Control Study	Barnegat Inlet to Cape May Canal, NJ	1959	Construction of 180' stone revetment & 90' timber bulkhead west of the lighthouse; reconstruction & extension of stone groin just east of lighthouse; construct two new timber groins south of lighthouse; widen 1,200' of beach by artificial placement
8	Barnegat Inlet Navigation Project: Modification of north jetty	Barnegat Inlet, NJ	1974	Raised inner 2700' of north jetty from –1' to +8' MLW
9	New Jersey Coastal Inlets and Beaches – Third Report	Barnegat Inlet to Longport, NJ	1974	Investigated damage problems along the oceanfront caused by storm tides and waves, inlet navigation problems,

				coastal erosion problems and beach recreation needs
10	New Jersey Coastal Inlets and Beaches – Fourth and Final Report	Sandy Hook to Island Beach State Park, NJ	1978	Investigated damage problems along the oceanfront caused by storm tides and waves, inlet navigation problems, coastal erosion problems and beach recreation needs
11	Manasquan Inlet Jetty Rehabilitation	Manasquan Inlet, NJ	1979-1982	Replaced armor-stone with 16-ton dolosse
12	Barnegat Inlet Phase I General Design Memorandum	Barnegat Inlet, NJ	1981	Design document to finalize planning and policy for a modification to the Barnegat Inlet Navigation Project
13	Monitoring of Completed Coastal Projects (MCCP) – Manasquan Inlet	Manasquan Inlet, NJ	1982-1985	Monitoring of stability and strength of dolosse placed at Manasquan Inlet
14	Manasquan River, Ocean and Monmouth Counties, New Jersey: Small Navigation Project Reconnaissance Study	Upper Manasquan River, NJ	1983	Investigated conditions in Manasquan River to determine a means of improving and maintaining navigable access and the economic feasibility under Section 107. Further study was not justified.
15	Barnegat Inlet Phase II General Design Memorandum	Barnegat Inlet, NJ	1984	Design document to finalize planning and policy for a modification to the Barnegat Inlet Navigation Project
16	New Jersey Shore Protection Study: Report of Limited Reconnaissance Study	Sandy Hook to Cape May, NJ	1990	Investigated the shore protection and water quality problems facing the entire ocean coast and back bays of New Jersey
17	Barnegat Inlet Navigation Project: Construction of new south jetty	Barnegat Inlet, NJ	1991	Constructed a new 4270' long south jetty parallel to north jetty
18	Monitoring of Completed Coastal Projects (MCCP) – Barnegat Inlet	Barnegat Inlet, NJ	1991-1997	Study of Barnegat Inlet includes performance of new south jetty, channel modifications and possible effects on adjacent beaches, the inlet and back bay
19	Seaside Park, New Jersey: Beach Erosion Control Reconnaissance Study	Seaside Park, NJ	1995	Investigate erosion and storm damage problems along the frontage of Barnegat Bay within the corporate boundaries of the Borough of Seaside Park, NJ
20	Barnegat Bay, New Jersey Expedited Reconnaissance Study	Barnegat Bay	1998	Recommended progression to the feasibility phase of study
21	Barnegat Bay GIS Study Watershed Analysis/Restoration Site Selection Approach Report	Barnegat Bay	1999	Comprehensive review of available data for the feasibility study area and development of a conceptual approach to ecoregional analysis and restoration site selection.
22	Barnegat Bay Ecosystem Restoration Site Selection	Barnegat Bay	2000	Implementation of the ecoregional analysis and restoration site selection approach. Identified 120 candidate restoration sites, of which 23 were judged to provide the best restoration opportunities

23	Barnegat Bay Ecosystem Restoration Environmental Testing and Restoration Proposals	Barnegat Bay	2001	Results of field investigations on the 23 priority sites.
24	Environmental Restoration of Dredged Hole #6, Barnegat Bay, New Jersey	Loveladies and Harvey Cedars	In process	Investigates feasibility of ecosystem restoration in dredged holes in Barnegat Bay.
25	Barnegat Bay Feasibility Study Fish Ladders at Lake Pohatcong & Manahawkin Lake	Tuckerton and Manahawkin	In process	Investigates feasibility of installing fish passage at two dams on streams.

Reports #20 through #23 were direct predecessors to this feasibility report and are discussed further here and in Chapter 4.

In accordance with the Water Resources Development Act of 1986, the Barnegat Bay study has been conducted in two phases, reconnaissance and feasibility. As per ER 1105-2-100, the objectives of the reconnaissance phase are to (1) determine if the water resource(s) problems warrant Federal participation in feasibility studies, (2) define the Federal interest, (3) complete a Reconnaissance Report, (4) prepare a Project Management Plan, (5) assess the level of interest and support from non-Federal entities, and (6) negotiate and execute a Feasibility Cost Sharing Agreement. This determines whether or not planning to develop a project should proceed to the more detailed feasibility stage. A Reconnaissance Report for the Barnegat Bay study was completed in 1997. The reconnaissance phase also included assessment of the non-Federal sponsor's (New Jersey Department of Environmental Protection) priorities and financial capabilities. As a result, it was agreed that the Barnegat Bay feasibility study focus would be limited to the following issues:

1. Ecosystem degradation and habitat loss
    - Freshwater wetlands restoration/creation
    - Salt marsh restoration
    - Restoration of abandoned lagoons
    - Submerged aquatic vegetation restoration

2. Fish and wildlife ecosystem degradation
    - Restoration of fishery habitat
    - Waterbird habitat restoration
    - Creation/restoration of islands

Two additional concerns were identified that are not considered primary benefit categories (i.e., the optimization of a proposed project will not depend upon their associated objectives being satisfied):

- Lack of safe public access to environmentally significant sites
  Construction of wildlife viewing platforms

- Bay flooding
  Flood reduction

In addition, it was agreed that, if possible, the process leading to construction would be accelerated for some projects. Studies #24 and #25 listed above are a result of this agreement on early action. In conclusion of the reconnaissance phase, a Feasibility Cost Sharing Agreement was signed by USACE and the New Jersey Department of Environmental Protection (NJDEP) in 1998. To date, no potential sponsor has demonstrated interest in pursuing other authorized activities.

After conclusion of the reconnaissance phase of the Barnegat Bay study, the feasibility phase began. The objective of feasibility studies is to investigate and recommend solutions to water resource problems. In the case of Barnegat Bay, a multi-step site selection and selected plan identification process was necessary in order to narrow the focus of study within the established issue areas. The process included the following five cycles, each of which is described in more detail in Chapters 4 and 5:

- Cycle 1: Comprehensive review of available data for the study area and development of a conceptual approach to ecoregional analysis and restoration site selection. (Table 1, Report #21)
- Cycle 2: Implementation of the ecoregional analysis and restoration site selection approach. Identified 120 candidate restoration sites, evaluation of which resulted in 23 sites being selected as the best restoration opportunities. (Table 1, Report #22)
- Cycle 3: Further refined understanding of the restoration problems and opportunities at the 23 sites by performing intensive field investigations (Table 1, Report #23). Process informed by Planning Aid Report prepared by United States Fish and Wildlife Service (USFWS). Followed by coordination with natural resource agencies to reach consensus on which sites to continue carrying forward through feasibility phase. Following six sites chosen:

  1. F & L Abandoned Lagoon (a.k.a. LAN05/LAN06)
  2. Bayville Abandoned Lagoon (a.k.a. LAC02)
  3. Oyster Creek (a.k.a. TWC21)
  4. Barnegat Lighthouse (a.k.a. TWS39)
  5. Stafford Forge (a.k.a. NWS02)
  6. Flat Island (a.k.a. ISS02)

- Cycle 4: Provided a set of conceptual design alternatives for each site. Alternative plans formulated based on amount of ecological benefit, considerations regarding future uses, technical constraints, and expected costs.
- Cycle 5: Identifies the costs of, and habitat units created by, each alternative. Uses IWR-Plan to evaluate cost effectiveness and incremental cost analyses. Considers additional feasibility factors to identify a selected plan for each site.

2.2 LIMITS OF SCOPE

This document provides information related to the biological, environmental and structural benefits and impacts of specifically identified types of ecosystem restoration at the above listed six sites in Barnegat Bay, Ocean County, New Jersey. All other biological or ecological problems at the sites or within the surrounding areas are outside the scope of this report.

2.3 RELATED INSTITUTIONAL PROGRAM

The National Estuary Program (NEP) was established by Congress under the Water Quality Act of 1987, Section 320. The purposes of the NEP are: (1) to identify nationally significant estuaries threatened by pollution, development, or overuse; (2) promote comprehensive planning, conservation and management of nationally significant estuaries; and (3) encourage the preparation of management plans and enhance coordination of estuarine research. These goals are to be achieved for the estuaries in the NEP by development of Comprehensive Conservation and Management Plans (CCMP).

The NEP is managed by the United States Environmental Protection Agency (USEPA). The Administrator of the USEPA selects estuaries for the program in response to nominations by State Governors, or, in the case of interstate estuaries, at the initiative of USEPA. Selection is based on issues of significant national concern regarding water quality, biological diversity, and recreational activities.

In 1995 the Barnegat Bay Estuary Program (BBEP) was included into the NEP, with activities to be cost-shared by USEPA and the NJDEP. The study area includes the Barnegat Bay watershed. The mission of the program reads thusly: "In cooperation with our community the Barnegat Bay Estuary Program is committed to action to restore, maintain, protect, and enhance the natural resources of the Barnegat Bay Estuary and its contributing watersheds through the 21st century." BBEP is guided by the following principles:

- Encouraging and motivating residents and visitors to maintain an ethic of responsibility for the bay and watershed.
- Educating people about the cultural heritage and historic traditions of the BBEP region for today.
- Implementing community based environmental planning for an increased quality of life and economic viability for the region.
- Integrating scientific data to prioritize the focal issues of point and nonpoint sources of pollution, habitat loss/open space, water quality degradation and the multiple interests in the watershed region.
- Promoting sustainable management of our ecosystem resources through consensus and cooperative efforts of citizens, businesses, local, state, and federal governments and other stakeholders.
- Acknowledging and planning for the rising population and increased uses of ground and surface water sources.
- Maintaining recreational and commercial fisheries through a healthy watershed.

The final CCMP for the BBEP was signed by New Jersey Acting Governor Donald DiFrancesco and USEPA Administrator Christine Whitman on May 15, 2002. Action 6.2 in the Habitat and Living Resources chapter of the CCMP relates directly to the Barnegat Bay feasibility study. (See below.)

ACTION 6.2: Conduct a Barnegat Bay ecosystem restoration feasibility study.

SIGNIFICANCE OF ACTION: The purpose of this feasibility study, which is phase two in a two-part U.S. Army Corps of Engineers (USACE) planning process, is to develop various ecosystem restoration projects for the Barnegat Bay estuary. These projects will help preserve and improve habitats for numerous species of plants and animals. The feasibility study will document and provide background data and support for the implementation of future restoration projects. The feasibility study will consider the following areas for restoration: fresh-water wetlands, salt marshes, abandoned lagoons, submerged aquatic vegetation, fisheries habitat, and waterfowl habitat (geese and ducks).

STATUS AND PRIORITY: Commitment. High Priority.

WHO: The feasibility study is a joint project between the USACE and the NJDEP.

HOW: The study began with the formation of a study team to conduct intensive site investigations for fast-track implementation opportunities. Existing conditions were characterized through data collection and structuring, and data have been entered into a comprehensive GIS database as appropriate.

Plan formulation will follow with the identification and screening of potential alternatives, and the evaluation of detailed plans that addresses the documented problems. The purpose of the formulation analysis is to identify plans that are publicly acceptable, implementable, and feasible from environmental, engineering, and socioeconomic standpoints.

By analyzing the alternative solutions in this manner, the solution that best fits the planning objectives and constraints can be formulated in a logical and efficient manner. An incremental analysis will be performed to optimize the solutions. Environmental quality benefits will be determined utilizing the Habitat Evaluation Procedure. When both the Corps and the non-federal sponsor are satisfied with the optimized plan, a draft feasibility report and a draft National Environmental Policy Act (NEPA) document will be produced. After a period of agency and public review a final report will be issued. If the final report recommends a construction project and funding is in place, the project will proceed to preconstruction, engineering and design, and then construction.

WHEN: October 1997 to December 2003. Potential fast-track restoration projects, including fish ladders on coastal tributaries and restoring habitat in deep dredge holes are nearing completion of preliminary planning.

WHERE: The feasibility study focuses on the Barnegat Bay, including Little Egg Harbor and adjacent lands.

MEASUREMENT OF EFFECTIVENESS: Recommendations for actions contained in the feasibility report will include monitoring plans to assess project performance.

COST ESTIMATE: $2.5 million for the feasibility study

FUNDING SOURCES: On September 15, 1995, the U.S. House of Representatives Committee on Transportation and Infrastructure requested that the USACE conduct a study of the Barnegat Bay estuary and surrounding areas to identify possible improvements in ecosystem restoration and protection. The Conference report, which accompanied the Fiscal Year 1998 Energy and Water Development Appropriations Act, contains feasibility phase funds for this project. The Barnegat Bay Ecosystem Restoration Study is budgeted to receive a total of $1.25 million in Federal funds during the study period, which is well under way. Section 105 of the Water Resources Development Act of 1986 specifies the cost sharing requirements applicable to the study. The State of New Jersey has agreed to provide $1.25 million during the study period, which will serve as the required match.

REQUIRED REGULATORY, ORDINANCE OR POLICY CHANGES: None currently identified.

2.4 PUBLIC INVOLVEMENT AND COORDINATION

Public involvement and coordination were initiated through the scoping process performed as part of the Environmental Assessment (EA) for the project. Responses to the scoping letter are summarized in Appendix D. Comments and information from the scoping process have been incorporated into this document. In addition, the USFWS prepared a Planning Aid Report that provided information on ecological resources within the vicinity of the project (USFWS 2001). Conclusions and recommendations in the Planning Aid Report have been incorporated into this document.

3.0 EXISTING CONDITIONS

This section describes the existing environmental conditions at each of the six sites included in this restoration project. These existing conditions provide a baseline for considering the potential impacts of selected plans on environmental and socioeconomic resources, as required by NEPA. They also provide the basis for understanding the plan formulation and development of alternatives to meet project goals. For clarity, the existing conditions at each site are presented separately; the same attributes are described for each site.

3.1 F&L ABANDONED LAGOONS

3.1.1 Physical Setting

This site, consisting of one F-shaped and one L-shaped abandoned lagoon, is located in Brick Township on the west side of the Bay, about 0.75 miles north of the Route 528 bridge to Mantoloking; it comprises approximately 29.7 acres. From local anecdotal information, it was apparently dug by developers in the early-to-mid 1970s and was never used. It is apparent that the lagoons were dug entirely from the native tidal marsh. The F Lagoon possesses an east-west main channel that connects directly to the Bay, and has two north-south branches, giving it the appearance of a large rotated "F" on an aerial photograph (see Figure 3-1). The L Lagoon possesses one east-west and one north-south branch, giving it the appearance of a large rotated "L" on an aerial photograph; it is connected to the Metedeconk River through a narrow channel on the north side (see Figure 3-2). These lagoons were excavated to a depth of approximately 14 feet, with 3.5-foot deep, 10-foot wide shelves adjacent to the banks. The site is bounded to the north by tidal marsh adjacent to the Metedeconk River, and to the east by the upper Barnegat Bay.

3.1.1.1 Physiography and Topography

Barnegat Bay watershed topography varies from rolling to flat. The Atlantic Coastal Plain rises from sea level along the coast to an altitude of about 200 feet in the northwest corner of Ocean County.

The terrain in the immediate vicinity of the site is flat. The view is obscured, however, in most areas of the site as a result of the tall, steep fill piles from the lagoon excavation; the excavated materials were deposited in steep piles directly adjacent to the open water. The channels of the lagoon were cut to a depth of approximately 15 to 17 feet (see results of bathymetric survey, below). The steep piles are composed of medium to coarse sand, and are very well-drained (they also possess the only upland vegetation on this largely tidal marsh landscape).

Substrate corings were made and measurements of the berms were recorded at the F Lagoon during the environmental testing field studies (Harriott and Southerland 2001). The sediment corings were made at several locations, evenly spaced along each berm. To aid in their description, the berms were numbered from west to east; the southern berm was numbered last (Berm 5). Berm 1 (farthest west berm) is an average of 71 feet wide, 12 feet tall (height above

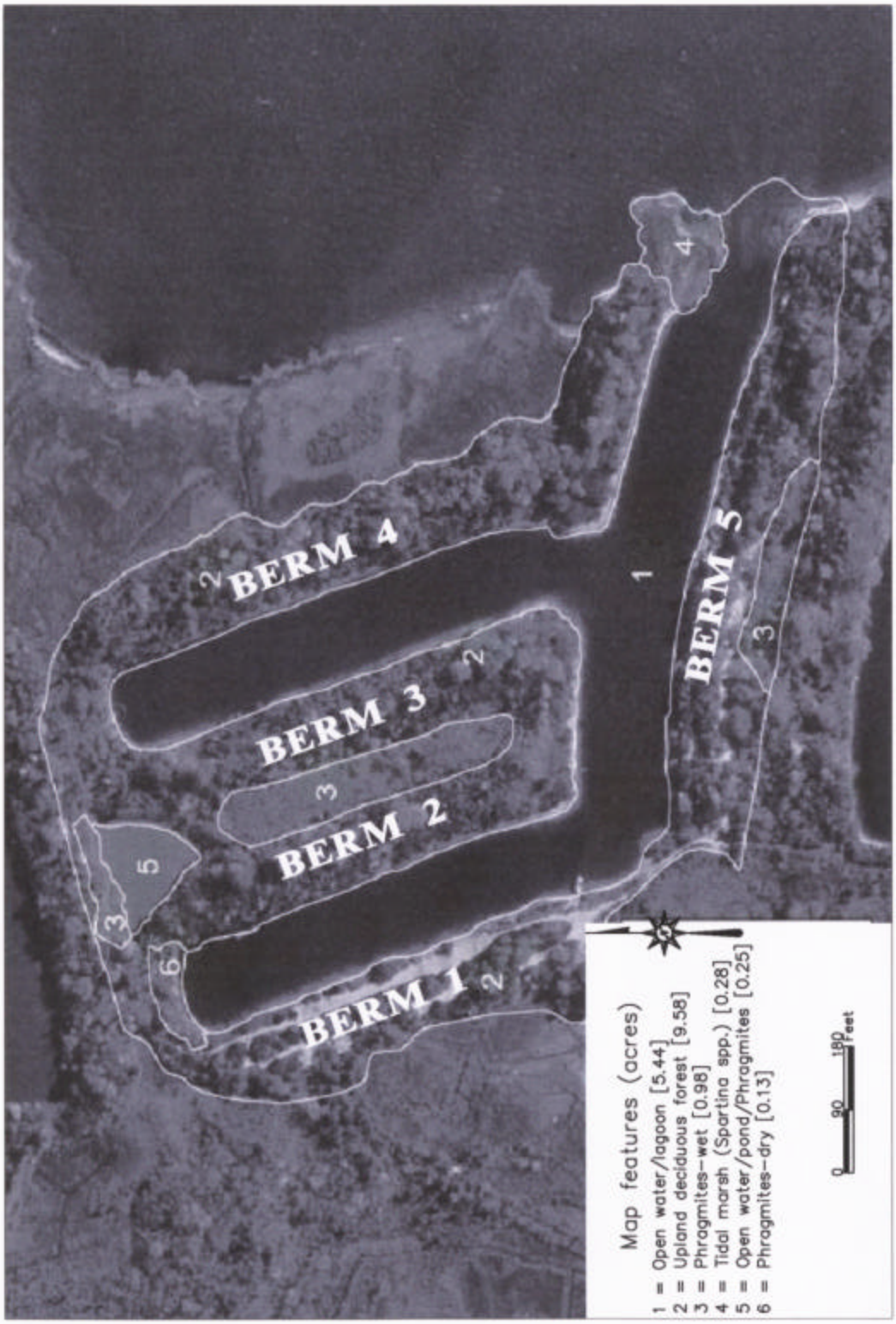


Figure 3-1 F Lagoon (Scale 1" – 180')

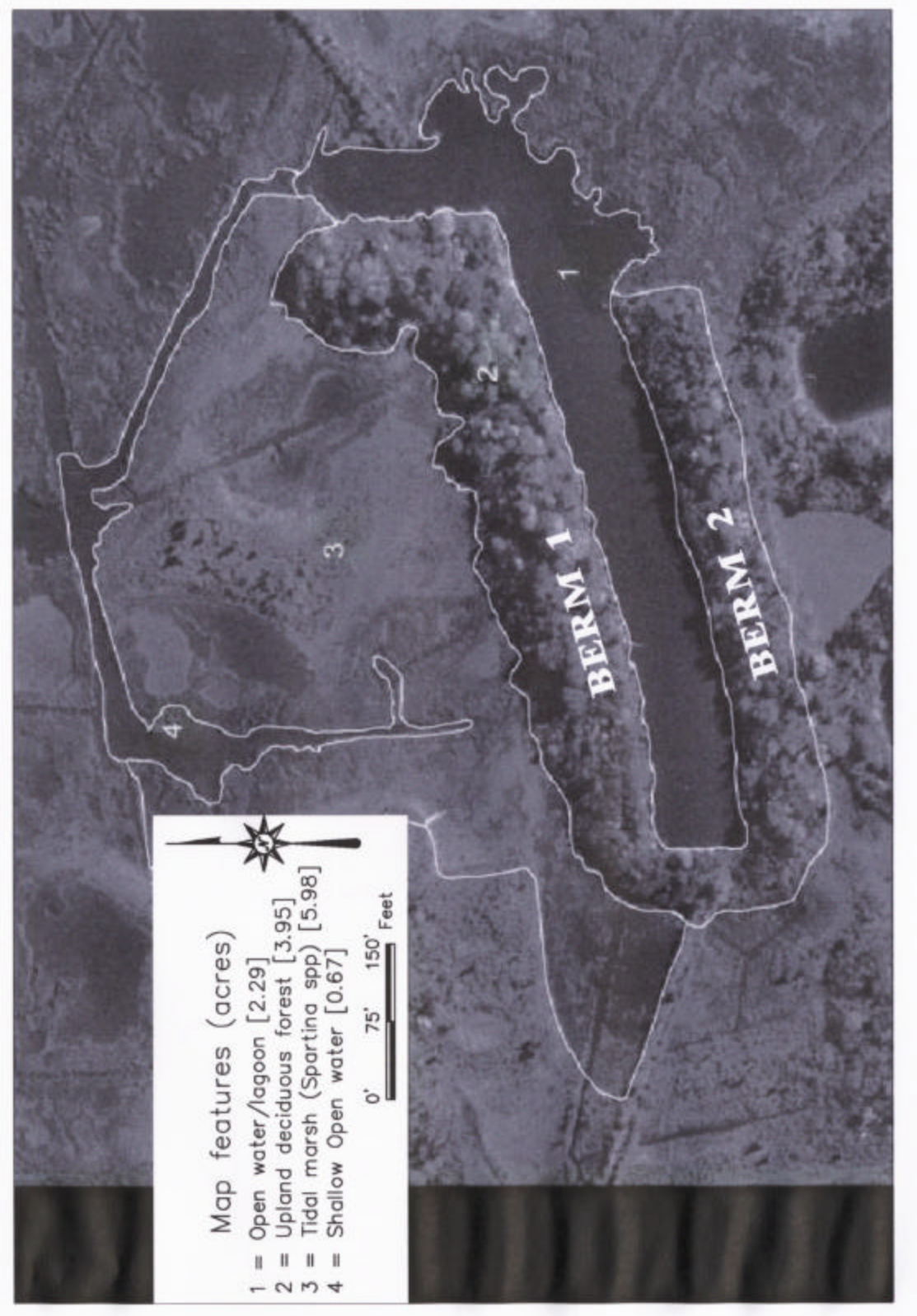


Figure 3-2 L Lagoon (Scale 1" – 150')

mean high water in lagoon), and is approximately 600 feet long. Berm 2 is an average of 77 feet wide, 17 feet tall, and is approximately 550 feet long. Berm 3 is an average of 83 feet wide, 25 feet tall, and is approximately 550 feet long. Berm 4 is an average of 49 feet wide, 10 feet tall, and is approximately 950 feet long. Berm 5 is an average of 49 feet wide, 10 feet tall, and is approximately 800 feet long. All of the berms are composed of medium to coarse sand, and appear to be relatively unstable (i.e., eroding) where they are not vegetated; this situation is exacerbated by the frequent human activity at the site, particularly in the vicinity of Berm 1. No groundwater was intercepted during the substrate corings on the berms.

Similarly, substrate corings were made and measurements of the berms were recorded at the L Lagoon during the environmental testing field studies (Harriott and Southerland 2001). The sediment corings were made at several locations, evenly spaced along each berm. Two berms exist at the site; for convenience, the northern-most berm is called Berm 1 and the southern berm is called Berm 2. In essence, Berm 1 is a large, L-shaped, steeply sided pile of excavated sandy material. It is roughly 96 feet wide, 800 feet long, and 15 feet tall (height above mean high water in lagoon). Berm 2 is roughly 65 feet wide, 600 feet long, and 10 feet tall. Both of the berms are composed of medium to coarse sand, and appear to be relatively unstable (i.e., eroding) where they are not vegetated. No groundwater was intercepted during the substrate corings on the berms.

Preliminary surveys performed in early 2002 at the F&L Abandoned Lagoons site by Andrews, Miller & Associates, confirmed the results of the earlier surveys by Versar (AMA 2002).

3.1.1.2 Climate

The climate in Ocean County, New Jersey is continental in nature. Winter temperatures average about 33ºFahrenheit (F), with an average county-wide minimum temperature of 24ºF. The average summer temperature is about 72ºF, with an average daily maximum temperature of 83ºF. Precipitation in the county is well distributed throughout the year; the growing season extends from April through September. About 52 percent of the average annual precipitation, equaling approximately 24 inches, falls during the growing season (USACE 2001).

3.1.1.3 Infrastructure

The F&L Abandoned Lagoons site is undeveloped and contains no paved roads, buildings, power facilities, rights-of-way, or other anthropogenic infrastructure. A system of dirt roads connects the site to Route 528 to the south. The roads apparently are linked to the former use of the site as a World War II-era U.S. Air Force radio station communications site (see subsequent sections for additional details). As a result of their un-maintained condition, many parts of these roads are currently inaccessible by motor vehicles such as trucks, although they are likely accessible by small vehicles like all-terrain vehicles or off-road motorcycles.

3.1.2 Environmental Setting

3.1.2.1 Land Use, Ownership, Management Plans

The F&L Abandoned Lagoons site is owned by the USFWS, and is included within the Edwin B. Forsythe refuge system. No specific management plans for the site are included as part of the revised draft USFWS Comprehensive Conservation Plan for the Edwin B. Forsythe Refuge (USFWS 2000). The F Lagoon site sees seasonally heavy use by boaters and anglers (although fishing is apparently poor; see the subsequent sections), and is apparently the site of occasional night parties (several large bonfire pits are present). This could be a result of the easy, unrestricted access from the water to the area and its relative inaccessibility from land. Boats of all types and sizes were regularly observed at the F Lagoon during the environmental testing field studies. Conversely, the L Lagoon can only be accessed by the smallest of boats (i.e., small Jon boats, canoes and kayaks) through a very narrow, shallow channel from the Metedeconk River. Footpaths exist along the west and south sides of the site. Access to the lagoons can be gained from Route 528, but it is a fairly long walk. A rope swing for swimming was observed in one location at the F Lagoon. For all the apparent use of the site, very little trash was seen.

3.1.2.2 Fisheries

Both seining and gill netting were performed at the F Lagoon during the environmental testing field studies to assess the fish population of the lagoon portions of the F&L Abandoned Lagoons site. The intent was to assess small, juvenile fish that inhabit the shallow areas of the lagoons by seining, and to sample larger fish of deeper habitats with the gill nets (Harriott and Southerland 2001). Seining was not performed in the deep waters of the F&L Abandoned Lagoons site. The seine used was a 75-foot-long, 8-foot-wide net; seining was done in shallow edge shelves (average of about 6 feet depth) off the southeast end of the western branch, at the southwestern end of the eastern branch, and on the northern side of the entrance to the lagoon. Many juvenile and small adult fish were captured with the seine; Table 3-1 presents the results. It must be noted, however, that these fish were caught only on the shallow shelves at the edges of the deep water in both lagoons.

An experimental gill net was also deployed in the eastern branch of the F Lagoon overnight to determine whether adult fish use the site. No fish were captured in the gill net. Based on this result, and observations of anglers using the site during the field studies (who caught no fish), it is likely that few, if any, adult fish frequent these waters.

The F&L Abandoned Lagoons site is adjacent to a large geographic area of Barnegat Bay mapped as Essential Fish Habitat (EFH); no EFH is mapped as part of the site. In its guide to EFH designations in the northeastern United States, NMFS provides a comprehensive summary of EFH designations completed by the New England Fishery Management Council, the Mid-Atlantic Fishery Management Council, the South Atlantic Fishery Management Council, and the NMFS, pursuant to the Magnuson-Stevens Fishery Conservation and Management Act (Act). The 1996 amendments to the Act strengthened the ability of NMFS to protect and conserve the

habitat of marine, estuarine, and anadromous finfish, mollusks, and crustaceans. This habitat is broadly defined to include "those waters and substrate necessary to fish for spawning, breeding, feeding, or growth to maturity" (NMFS 1999). Under the Act, the NMFS must coordinate with other Federal agencies that could adversely affect EFH. In turn, NMFS must provide recommendations to Federal and State agencies on such activities to conserve EFH. These recommendations may include measures to avoid, minimize, mitigate, or otherwise offset adverse effects on EFH (NMFS 1999).

Table 3-1 Results of seining in shallow shelf areas in three locations at the F Lagoon and two locations at the L Lagoon of the F&L Abandoned Lagoons site, on 1 June 2000. Seining was not performed in the deep waters of the F&L Abandoned Lagoons site (as originally presented in Harriott and Southerland 2001). Deepwater habitats at the site likely support few fish because of poor water quality, particularly low levels of dissolved oxygen.

F LAGOON RESULTS		
Scientific Name	**Common Name**	**Notes**
Fundulus heteroclitus	Mumichog	abundant (>100 total)
Menidia menidia	Atlantic silverside	abundant
Pleuronectes americanus	Winter flounder	about 16 total, each approx.1.5 inches
Calinectes calinectes	Blue crab	several small juveniles
Palaemontes pugio	Grass shrimp	abundant
Beroe ovata	Pink comb jelly	about 20 total
L LAGOON RESULTS		
Scientific Name	**Common Name**	**Notes**
Fundulus heteroclitus	Mumichog	abundant (>100 total)
Fundulus majalis	Striped killifish	abundant
Menidia menidia	Atlantic silverside	abundant
Brevoortia tyrannus	Atlantic menhaden	several individuals
Mugil cephalus	Striped mullet	several individuals
Leiostomus xanthurus	Spot	several individuals
Pomatomus saltatrix	Bluefish	several small juveniles
Calinectes calinectes	Blue crab	Three small juveniles
Palaemontes pugio	Grass shrimp	abundant
Beroe ovata	Pink comb jelly	abundant

3.1.2.3 Benthic Community

There were no benthic invertebrate samples specifically taken at any of the six sites considered under this project. There are data, however, on benthic communities present in the southern part of the Barnegat study area that are likely comparable to the communities in the abandoned lagoon and other tidal sites. These data were obtained as part of the feasibility study for dredged holes restoration in Barnegat Bay (Scott and Kelley 1999; USACE 2001). The benthic

communities at the dredged holes sites are in the same geographic region and in similar estuarine habitats as those being considered under this feasibility study. Therefore, as a basis for later evaluation of potential effects on the benthic communities at the six sites, the following benthic data from studies at the dredged holes sites are presented as likely existing conditions.

Dredged Holes Benthic Study Results. Benthic macroinvertebrates were sampled in the spring and summer to evaluate recruitment and community conditions within each hole. The spring survey (conducted on May 26, 1999) was used to determine whether recruitment at various depths within the dredged holes was different than recruitment at naturally occurring depths. A summer benthic survey (conducted on August 4 and 5, 1999) was used to evaluate benthic community conditions during a period when dissolved oxygen stress was expected to be the highest.

Two depth strata (deep and intermediate) were sampled within each hole to determine if there was a depth-related change in benthic community characteristics. Deep samples ranged from 16 to 33 feet deep (with a mean of 24.5 feet) and intermediate samples ranged from 6 to 15 feet deep (with a mean of 10.2 feet). Reference sites immediately adjacent to each hole were sampled to estimate the benthic community characteristics that occur naturally in the shallow waters of Barnegat Bay (shallow samples ranged from 2.5 to 5 feet with a mean of 3.3 feet).

Benthic samples were collected with a 0.044-m^2 stainless steel Young grab sampler. The benthic samples were sieved in the field using a 0.5-mm mesh screen. The material retained on the screen was bottled and preserved in a 10% buffered formalin solution stained with rose bengal.

The community composition of each hole and surrounding shallow areas were similar to each other, between seasons, and between the various depths. In general, arthropods, specifically amphipods (small shrimp type crustaceans) and polychaete worms dominated the benthic community. This was true in both seasons, as well as at the different depths. The numerically dominant amphipods were in the genus *Ampelisca* spp., while the numerically dominant polychaetes were in the Capitellidae family (i.e., *Mediomastus ambiseta* and *Capitella capitata*). In addition, the majority of the epifaunal species collected from the area were amphipods.

Diversity was the greatest in the shallow habitats. Diversity in the deepest areas was extremely low in both seasons, as intermediate depths also had depressed diversity.

The number of large taxa collected in the samples was also examined, and for this summary, large taxa were defined as species with lengths greater than 2 cm. Sites containing many large individuals generally suggest the presence of a long-lived, established benthic community subjected to little stress. The shallow areas contained numerous large taxa while the intermediate area contained some large taxa. No large taxa were collected from the deep areas.

The shallow areas near the two dredged holes are highly productive areas with high diversity, abundance, and biomass of benthic organisms. On the other hand, the benthic communities within each hole, in both the intermediate and deep areas, are clearly depressed compared to the surrounding shallow areas. Though the intermediate areas support a benthic community, and in

some cases support high numbers of amphipods, all measures of benthic community health (including diversity, abundance, and biomass) were less than those found at nearby areas with "natural" depths. The deepest areas of each hole were essentially azoic in the summer and spring recruitment was extremely depressed.

Regression analysis indicated that there was a relatively strong relationship between benthic community condition and depth. Samples collected from the deepest habitats resulted in essentially no organisms, while the intermediate and shallower depths showed strong increases in all three benthic measures. While a high degree of variation in total abundance and biomass of benthic organisms was observed in the shallow reference samples, the data suggest that filling the holes to reference site depths would have the greatest net benefit to benthic community productivity. This is particularly true for diversity as the shallow water sites consistently yielded higher numbers of species. At the same time, evidence that fish use the intermediate depths, and that benthic communities are productive at such depths, argue for the intermediate depth as the best choice for overall ecological improvement.

3.1.2.4 Other Wildlife

During the fish studies, it was noted that diamondback terrapins (*Malaclemys terrapin terrapin*) frequent the site and its vicinity. The terrapins were often observed swimming at the surface of both lagoons during the field studies. One large individual (approximately 10 inches long; it may have been a female) was observed basking on an abandoned, half-submerged dock at the northern end of the western branch of the F Lagoon. Several weeks later during a subsequent visit to the site (mid-June 2001), a female terrapin (not the large individual) was observed laying eggs on the berm immediately west of the western branch at the F Lagoon. The terrapin had dug a scrape in a very small open area in the middle of the footpath on top of the berm, and was in the process of laying eggs (several eggs were already visible in the scrape). The status of the terrapin population in the vicinity of the site is not known at this time. Existing habitats for terrapin egg-laying at the F&L Abandoned Lagoons site consist of these narrow footpaths, and are of extremely poor quality.

Other wildlife and their signs (tracks, scats, calls, and other identifiable physical evidence) observed at and near the F Lagoon while conducting the field studies included muskrat (*Ondatra zibethicus*), black-crowned night heron (*Nycticorax nycticorax*), eastern kingbird (*Tyrannus tyrannus*), yellow warbler (*Dendroica petechia*), red-winged blackbird (*Agelaius phoeniceus*), and American goldfinch (*Carduelis tristis*). One muskrat was observed in the brackish marsh off the site to the west. Approximately six black-crowned night herons were observed in small trees adjacent to the small triangular shallow pond in the north-central part of the F Lagoon. Despite a brief search, no night heron nests were found in the vicinity of where the birds were observed; it is not currently known how these birds use the site. Several eastern kingbirds, yellow warblers, and American goldfinches were observed flying near the edges of the F Lagoon; it is probable that these species all nest in the vicinity of the site. Red-winged blackbirds were observed in the vicinity of the small triangular shallow pond in the north-central part of the F Lagoon; it is also likely that they nest in this area.

Wildlife and their signs (tracks, scats, calls, and other identifiable physical evidence) observed at and near the L Lagoon while conducting the field studies included herring gull (*Larus argentatus*), greater black-backed gull (*Larus marinus*), green heron (*Butorides striatus*), and black-crowned night heron. All of these birds, with the exception of the green heron (one individual seen on the western end of the site) were observed in the tidal marsh to the northeast of the L Lagoon. A large, very shallow tidal pool (only a few inches deep at high tide) area exists to the immediate northeast of the L Lagoon, where many gulls were observed loafing and resting. No songbirds were observed in the scrubby upland forest on the berms.

3.1.2.5 Vegetation and Land Cover

Existing vegetation and land cover were mapped at the Barnegat sites during the environmental testing studies conducted for the project (Harriott and Southerland 2001); this information is subsequently presented on figures in Chapter 5 of this report. The primary vegetation type at the F&L Abandoned Lagoons site is upland deciduous forest (areas 2). The trees and shrubs colonized the steep, well-drained sand piles that border both lagoons. The scrubby forest is characterized by locally dense areas of very small trees and shrubs; other areas are open and less dense. The largest trees present are black cherry (*Prunus serotina*); these are scattered, and are a maximum of about 10 inches diameter at breast height (dbh). The average size of the trees on site is about 4 to 6 inches dbh. Other tree species in the forest include sassafras (*Sasafrass albidum*) and red cedar (*Juniperus virginiana*). Shrubs and woody vines observed include bayberry (*Myrica pensylvanica*), smooth sumac (*Rhus glabra*), Virginia creeper (*Parthenocissus quinquefolia*), poison ivy (*Toxicodendron radicans*), and Japanese honeysuckle (*Lonicera japonica*). The herbaceous layer of the forest was almost nonexistent in most areas, and consisted of occasional, weak phragmites (*Phragmites australis*). It should be noted that this scrubby forested community is an artificial anthropogenic artifact (of potentially illicit activities) that directly displaced ecologically valuable native tidal marsh and its attendant suite of species.

Three small parcels of phragmites marsh exist in the northern, central, and southern parts of the F Lagoon (areas 3). A large parcel of tidal marsh actually composes the majority of the vegetation north of the L Lagoon as mapped. This large area of tidal marsh was included as part of the site so that it could be properly accounted for and protected during future restoration efforts. The tidal marsh is relatively undisturbed, and its principal species are salt marsh cordgrass (*Spartina alterniflora*), salt hay (*Spartina patens*), marsh spike grass (*Distichlis spicata*), and high tide bush (*Iva frutescens*). It is also interspersed with small tidal pools, salt panes, and tidal guts. It should also be noted that a large area exists to the northwest of the site where the tidal marsh is disturbed by apparently small amounts of fill; this area possesses an odd mixture of red cedar (*Juniperus virginiana*), high tide bush, and both species of cordgrass. Two sections of an abandoned road bed (now a narrow footpath) extend off the L Lagoon from its eastern and western ends off site into the marsh. From review of old United States Geologic Survey (USGS) topographic quadrangles, it is apparent that these roads were constructed as part of the Adamston United States Air Force (USAF) Radio Station; they appear to be the only remaining relic of this previous use.

The small parcels of phragmites marsh at the F Lagoon possess dense, monotypic stands of phragmites, and little other vegetation. One parcel mapped as shallow water adjacent to the F Lagoon (area 5) also possessed abundant phragmites (in some areas the open water was grown over by the phragmites). One very small parcel of phragmites on uplands was also mapped adjacent to the F Lagoon (area 6). The only tidal marsh observed on the F Lagoon was a small parcel in the eastern-most part (area 4); salt marsh cordgrass (*Spartina alterniflora*) and salt hay (*Spartina patens*) were the principal species. The remainder of the site is composed of the deep open water of the lagoons. It should be noted that the site is also bounded to the east and west by tidal marsh (similar in species composition to area 4 on the site).

3.1.2.6 Threatened and Endangered Species

The New Jersey Natural Heritage (Heritage) database indicates that records exist for osprey (*Pandion haliatus*) in the vicinity of the F&L Abandoned Lagoons site. According to the location description provided by Heritage, however, the 1992 record was from a location clearly off the F&L Abandoned Lagoons site. Ospreys are listed in New Jersey as Threatened and their breeding populations are considered imperiled in the state. They are considered globally secure, however, throughout their naturally occurring range. Ospreys were occasionally observed flying in the general area of the site; no nests were observed within the Barnegat study area. Based on the general nature of the proposed restoration and the size of the F&L Abandoned Lagoons site relative to adjacent habitats on the Bay, it is unlikely that ospreys would be either positively or negatively affected by the proposed restoration project. Several nesting platforms could be installed as part of the restoration, but this would not be expected to make a significant positive impact on the species.

3.1.2.7 Wetlands

As mapped in the recent environmental testing report (Harriott and Southerland 2001), a total of approximately 15.9 acres of tidal and freshwater wetlands exist at the F&L Abandoned Lagoons site. Refer to the previous section on Vegetation and Land Cover for a description of wetlands vegetation and other land cover. Prior to the human disturbances at the site, including construction of a USAF antenna and facilities (now gone from the site, with the exception of several small access roads), and excavation of the lagoons, the entire site was historically tidal wetlands. All upland vegetation existing at the site (most of it on the steep piles of excavated materials from the lagoons) is a result of these human disturbances to the original wetlands. The tidal marshes that remain on the site are largely undisturbed because of their relative inaccessibility. Particularly large areas of tidal marsh exist directly to the north and east of the L Lagoon. Two very small parcels of nontidal wetlands exist on the F Lagoon site; one possesses dense phragmites, and the other is a small shallow pond also partially enclosed by phragmites. The tidal marshes on and adjacent to the F&L Abandoned Lagoons site are extremely valuable to area wildlife, particularly long legged wading birds and waterfowl.

3.1.2.8 Air Quality

There are several air monitoring stations in southeastern New Jersey. The Edwin B. Forsythe National Wildlife Refuge, extending along the Ocean County coast, monitors ambient ozone and sulfur dioxide concentration. Carbon monoxide, total particulates, and lead are monitored at an Atlantic City, New Jersey station; another station in Millville, New Jersey monitors nitrogen oxides (USACE 2001).

USEPA has reported that ozone levels within Ocean County persistently exceed national air quality standards, causing the county to be classified as a non-attainment area for ozone. All other pollutants listed by USEPA are currently in attainment status (USACE 2001).

3.1.2.9 Hazardous, Toxic & Radioactive Waste

In accordance with ER 1165-2-132, entitled *Hazardous, Toxic and Radioactive Wastes (HTRW) Guidance for Civil Works Projects*, dated 26 June 1992, investigations must be conducted to assess the existence, nature and extent of HTRW within a project impact area (Comprehensive Environmental Response, Compensation, and Liability Act [CERCLA], 42 U.S.C. > 9601 et seq., as amended). Hazardous substances regulated under CERCLA include "hazardous wastes" under Section 3001 of the Resource Conservation and Recovery Act (RCRA), (42 U.S.C. 6921 et seq.), "hazardous substances" identified under Section 311 of the Clean Water Act (33 U.S.C. 1317); "hazardous air pollutants" designated under Section 112 of the Clean Air Act (42 U.S.C. 7412); and "imminently hazardous chemical substances or mixtures," upon which USEPA has taken action under Section 7 of the Toxic Substance Control Act (15 U.S.C. 2606).

To comply with the HTRW sections as mandated under CERCLA, Environmental Data Resources (EDR) was retained to conduct assessments of the potential presence of hazardous, toxic, or radioactive waste at the six Barnegat sites. Several sources of data were consulted to complete the HTRW evaluation and to determine the potential for encountering on-site hazards. Each assessment by EDR included searches of Federal and state data bases; CERCLIS and NPL data bases; RCRA data bases; the ERNS data base; the CORRACTS data base; the SPL data base; permitted solid waste disposal; state UST and LUST sites; as well as other data sources.

Existing data base information (as well as site observations during the ecological field studies) suggests little potential for encountering hazards on the F&L Abandoned Lagoons site. The EDR report also indicates that there are no potential hazards on any directly adjacent properties. Several records of minor spills at a local marina farther than ¼ mile were mapped by EDR; other minor spill sites were also noted farther from the F&L Abandoned Lagoons site. These mapped "contaminated" sites are not likely to have any negative effect on the proposed restoration.

3.1.2.10 Water Resources

Surface water quality was measured at three locations on the F&L Abandoned Lagoons site: the southwest corner of the western arm of the F Lagoon, the off-site pond at F Lagoon, and the main channel of the eastern arm of the F Lagoon. Table 3-2 presents the results. Several items were of note in the lagoons. First, the salinity is high, at about 21 to over 29 parts per thousand. Second, the dissolved oxygen levels were fairly high at the F Lagoon, despite its depth; this is probably a result of the apparently good flushing that takes place in this lagoon. Dissolved oxygen at the L Lagoon, however, was very low at depth, likely attributable to poor flushing in this lagoon. Water quality data (same parameters as shown on Table 3-2) were also collected over a 24-hour period at a point location on the L Lagoon; results further demonstrated low dissolved oxygen levels at depth during all tide cycles. Temperatures were also very cold at depth in both lagoons. There was also a difference in salinity between the off-site, isolated pond (W2, brackish) adjacent to F Lagoon and the sea water-strength salinity of the lagoon water (it is obvious that these two systems are not currently connected).

Table 3-2 Results of water quality testing done at the F&L Abandoned Lagoons site for the Barnegat Environmental Testing field studies. Refer to Harriott and Southerland 2001 for 24-hour data from the L Lagoon.

Sampling Location on F Lagoon	pH	Salinity (o/oo)	D.O. (mg/L)	Specific Conduc-tivity (mS/cm)	Temp (C°)	Turbidity (NTU)
F Lagoon						
W1 (SW corner of W arm; 4 ft.)	7.54	24.46	8.92	36.95	17.49	20.9
W2 (offsite pond; 12 inches)	8.41	6.67	11.55	11.63	19.22	30.2
W3 (main channel, off E arm; 15.1 ft.)	7.25	29.18	8.30	45.02	13.99	27.0
L Lagoon						
W1 (western end, 5.1 meters)	6.17	28.88	1.43	44.81	11.33	40.5
W1A (same as W1, 1.1 meters)	7.30	21.84	9.50	34.85	28.02	28.8

3.1.2.11 Geology and Soil

Substrate corings were made and measurements of the berms were recorded during the field studies (Harriott and Southerland 2001). The sediment corings were made at several locations, evenly spaced along each berm. For convenience, the northern-most berm on the L Lagoon is

called Berm 1 and the southern berm is called Berm 2. In essence, Berm 1 is a large, L-shaped, steeply-sided pile of excavated sandy material. It is an average of roughly 96 feet wide, 800 feet long, and 15 feet tall (height above mean high water in lagoon). Berm 2 is an average of 65 feet wide, 600 feet long, and 10 feet tall. Both of the berms are composed of medium to coarse sand, and appear to be relatively unstable (i.e., eroding) where they are not vegetated. For the F Lagoon, the berms were numbered from west to east; the southern berm was numbered last (Berm 5). Berm 1 (farthest west berm) is an average of 71 feet wide, 12 feet tall (height above mean high water in lagoon), and is approximately 600 feet long. Berm 2 is an average of 77 feet wide, 17 feet tall, and is approximately 550 feet long. Berm 3 is an average of 83 feet wide, 25 feet tall, and is approximately 550 feet long. Berm 4 is an average of 49 feet wide, 10 feet tall, and is approximately 950 feet long. Berm 5 is an average of 49 feet wide, 10 feet tall, and is approximately 800 feet long. All of the berms are composed of medium to coarse sand, and appear to be relatively unstable (i.e., eroding) where they are not vegetated; this situation is exacerbated by the frequent human activity at the site, particularly in the vicinity of Berm 1. No groundwater was intercepted during the substrate corings on the berms.

A simplified bathymetric survey was performed to determine the approximate depths, bottom contours and substrates of the F and L Lagoons. At the F Lagoon, ten stations were evenly distributed throughout the lagoon (middle and sides); at the L Lagoon, 11 stations were evenly distributed throughout the lagoon (middle and sides). All bathymetric stations were sampled for depth and dominant substrate; results are presented in Table 3-3.

3.1.3 Recreational Facilities

There are no recreational facilities established on the F&L Abandoned Lagoons site. Many recreational boaters use the F Lagoon, however, because of the easy, unrestricted access from the water. Boats of all types were observed during the environmental testing field studies. Most of the boaters observed appear to use the F Lagoon site as a place to tie up their boats and relax. One rope swing was observed at the F Lagoon, but it is surmised that the temperatures are too cold at depth in the lagoon for swimming most of the year. Anglers were occasionally observed fishing at the F Lagoon site. Based on conversations with some of the anglers during the environmental testing field studies, however, it is apparently not a good fishery. Access to the L Lagoon is very difficult by boat or land, and few people apparently ever use the site.

3.1.4 Cultural Resources

In preparing the draft Feasibility Study, USACE has consulted with the New Jersey State Historic Preservation Office (NJ SHPO) and other interested parties in order to assess the potential for historic properties in the project area as required under Section 106 of the National Historic Preservation Act of 1966, as amended, and its implementing regulations, 36 CFR Part 800. Section 106 consultation with the NJ SHPO is continuing and will be concluded prior to any project construction activity. The following brief summary outlines several cultural resources investigations conducted by USACE in the Barnegat Bay area and provides a very general history of the region.

USACE has conducted several cultural resources investigations in the Barnegat Bay region in preparation for possible construction of flood control measures in the Manasquan River Basin, proposed ocean shoreline protection projects along the barrier islands between Manasquan Inlet and Long Beach Island, and maintenance activities associated with the operation of Barnegat Bay Inlet. USACE conducted a Phase 1A cultural resources investigation in 1978 in preparation for inlet dredging, shoreline sand placement and new jetty construction at Barnegat Inlet (Gilbert/Commonwealth, 1979). Researchers identified 13 historic properties in the project area vicinity utilizing records background research and on site field reconnaissance. No prehistoric sites were identified.

***Table 3-3 Results of bathymetric survey performed at the F&L Abandoned Lagoons site for Barnegat Environmental Testing (as originally presented in Harriott and Southerland 2001).**

Station #	Water depth (feet)	Substrate	Notes
F LAGOON			
B1	14	fine silt	black, odorous muck
B2	15	fine silt	black, odorous muck
B3	15	fine silt	black, odorous muck
B3A	10	sand/silt	depth where sand ends/silt begins
B4	14	fine silt	black, odorous muck
B5	16	fine silt	black, odorous muck
B6	11	sand/fine silt	sand with thin layer of black silt on top
B7	15	fine silt	black, odorous muck
B8	14	fine silt	black, odorous muck
B9	13	fine silt	black, odorous muck
B10	3.5	medium sand	grey sand on shallow "shelf"
L LAGOON			
A	15.00	fine silt	black, odorous muck
B	5.00	coarse sand	sand with thin top layer of mud; break point here
C	15.00	fine silt	black, odorous muck
D	15.00	fine silt	black, odorous muck
E	13.00	fine silt	black, odorous muck
F	14.00	fine silt	black, odorous muck
G	14.00	fine silt	black, odorous muck
H	11.00	fine silt	black, odorous muck
I	5.00	coarse sand	sand with thin top layer of mud; break point here
J	4.00	coarse sand	small shoal area, inside "L" bend
K	11.00	fine silt	black, odorous muck

USACE has completed four cultural resources studies in the northern Barnegat Bay area. The first study, entitled A Phase 1A Cultural Resources Investigation of the Manasquan River Basin, Monmouth and Ocean Counties, New Jersey (Hunter Research Inc. 1993), generated a cultural resource database for the Manasquan River watershed as a planning tool in the development of flood control improvements in the 80 square mile basin. The second investigation entitled Phase 1A Cultural Resources Investigations, Manasquan Inlet to Barnegat Inlet, Ocean County, New Jersey (Hunter Research Inc. 1997) compiled existing cultural resource information from archival and historic map sources to identify known and expected historic properties in that coastal area. In addition, a low-tide pedestrian archeological survey was conducted along the shoreline in the northern portion of the project area from Manasquan Inlet to the northern boundary of Island Beach State Park. One possible shipwreck site was identified in the near-shore surf zone.

In the third study, entitled Phase I Submerged and Shoreline Cultural Resources Investigations, Manasquan Inlet to Barnegat Inlet, Ocean County, New Jersey (Dolan Research, Inc. 2001), researchers investigated proposed project offshore borrow areas, submerged near-shore locations, and terrestrial shoreline areas utilizing magnetometer, side-scan, and bathymetric data collection techniques. Nineteen remote sensing targets exhibiting shipwreck characteristics were identified in the submerged portion of the near-shore area. In the fourth study, entitled Supplemental Phase I Submerged Cultural Resources Investigations, Borrow Area "B", Manasquan Inlet to Barnegat Inlet, Ocean County, New Jersey (Dolan Research, Inc., 2001), researchers conducted remote sensing in an expanded portion of offshore Borrow Area B. No significant cultural resources were identified.

USACE completed two cultural resources investigations in the southern Barnegat Bay area in association with proposed ocean shoreline protection activities on Long Beach Island. The first study, entitled Phase I Submerged and Shoreline Cultural Resources Investigations and Hydrographic Survey, Long Beach Island, Ocean County, New Jersey (Hunter Research, Inc., Dolan Research Inc. and Enviroscan, Inc., 1998) discusses the results of near-shore tidal and offshore borrow area investigations. Eleven underwater targets exhibiting shipwreck characteristics were identified. In a follow-up investigation entitled Supplemental Phase IB and Phase II Cultural Resources Investigations, New Jersey Atlantic Coast, Long Beach Island, Ocean County, New Jersey (Dolan Research, Inc., 2001), researchers discuss the investigation of the eleven targets identified in the previous study. Two of the targets were found to be shipwrecks that appear to meet the minimum eligibility requirements for listing on the National Register of Historic Places. The following historical summary is taken directly from the above referenced reports.

The majority of documented prehistoric sites in the Barnegat Bay vicinity are from the Woodland Period and are concentrated around the tidal estuaries of the Barnegat Bay and Manasquan Rivers. Notable features of the archaeology of this area are shell-middens and Native American burials. However, no burials are recorded from the Atlantic shoreline itself. Three prehistoric sites have been documented in Point Pleasant Beach and Ortley Beach, Dover Township. The recent discovery of a Paleo-Indian fluted point in Island Beach State Park is a significant find from this early period along the New Jersey shore. Despite a statewide survey of

archaeological resources conducted in the early part of this century and more recent cultural resources investigations, no confirmed prehistoric sites have been identified within the tidal zones of the Bay or ocean shorelines on Long Beach Island itself.

The increasing population of the area in the third quarter of the 19th century led to the establishment of a number of incorporated communities from 1886 onward. These include Bay Head Borough (1886), Harvey Cedars (1894), Island Beach Borough (1933-1965), Lavallette Borough (1887), Mantoloking Borough (1911), Point Pleasant Beach Borough (1886), Seaside Heights Borough (1913) and Seaside Park Borough (1898).

A review of the historic map coverage of the project area documents the development of the shore from a barely-inhabited barrier island to a fully-developed resort community. At the time of the 1776 Holland Map no settlements or isolated dwellings were shown on the barrier islands. The mainland area is described as "Sandy Barren Deserts", and only one road reached the coast in the project area, opposite Barnegat Inlet. A second inlet, identified as "New Inlet" lay north of Barnegat Inlet in the area of the present Toms River. By 1850, eight individual structures, five of them with owner's names attached, are shown on the island. The New Inlet of 1776 was subsequently renamed Cranberry Inlet but is marked as closed on the 1850 map. It had apparently filled in by about 1812.

The 1872 Beers map shows a minor increase in recreational use of the region. The development of Point Pleasant continues and three roads lead to the shoreline from the Manasquan River area. Numerous hotels and boarding houses shown include the Ocean Hotel and Cook property near the Manasquan River, Chadwick's Hotel in Chadwick, an unnamed hotel in the present Seaside Heights, and Reed's Hotel within the present limits of Island Beach State Park. Three life saving stations are also shown.

An 1878 map shows two planned seaside resort communities in the project area, Lavallette and Seaside Heights, and six life-saving stations, all numbered on the national system and given identifying names. By 1883, a railroad connection ran down the Island from the north as far down as Seaside Park, from where it crossed Barnegat Bay south of Toms River. Since the late 19th century much of the remainder of the coast has been developed. Island Beach State Park was set aside prior to World War II, during which time this area was used for missile development and testing. The park was formally opened in 1959.

Although Barnegat Bay was utilized by local anglers and sportsmen throughout the 19th and 20th centuries, the majority of commercial shipping occurred in the shipping lanes running adjacent to the island's Atlantic Ocean shoreline. Over the centuries numerous ships have been wrecked along New Jersey's 127-mile-long coast line and a great number occurred specifically off Long Beach Island. By the first quarter of the 19th century, volunteer life saving stations had been established in many locations along New Jersey's coast. The first Federal assistance came in 1823, when an appropriation was made for the construction of a lighthouse at Cape May. Following the construction of the Cape May Lighthouse, a series of lighthouses were constructed along the New Jersey shoreline, including the Barnegat Lighthouse Tower and the Little Egg Harbor Light.

Between 1848 and 1878, a total of at least 125 shipwrecks have been documented off the Atlantic coastline between Barnegat Inlet and Manasquan Inlet. A single historic vessel has been archaeologically recorded in the project area. In 1988, the remains of a boat were located at the intersection of the southbound lane of Route 35 with Fielder Avenue in Ortley Beach, about 250 yards west of the shore. The vessel was undated.

The first Federal appropriation for life saving stations in any state occurred in 1848 when $10,000 was set aside to provide for life boats, rockets and the construction of eight life saving stations on the New Jersey coast between Sandy Hook and Little Egg Harbor. The observation towers, small wooden buildings and tiny boats associated with these posts were the only means of defense against the loss of human lives. Initially, there were two life saving stations on Long Beach Island. The first was located at Harvey Cedars and the second near Bond's Hotel. In 1870, Congress provided the first funds for a professional United States Life Saving Service and in 1886, the Federal government inaugurated the policy of manning all stations with paid crews. Lovelady's Island, Harvey Cedars and Long Beach Life Saving Stations still stand today in their original locations. The 1898 U.S. Life-Saving Station #14 at Island Beach State Park is listed on the National Register of Historic Places and the Point Pleasant Beach Coast Guard Station is considered eligible for listing.

3.1.5 Socioeconomic Environment

F&L Lagoon is located within the township of Brick, Ocean County, NJ. In the year 2000, Brick had a total population of 76,119, consisting of 47.5 percent males and 52.5 percent females. This was an increase of 14.5 percent, nearly ten thousand people since 1990, when the US Census recorded a population of 66,473 people for this township. The median age for Brick Township in 2000 was 39.4 years.

There were 29,511 households with the average household size being 2.56 people. The average family size was 3.07 people. The total housing units in 2000 was 32,689. There were 29.511 occupied housing units, which was 90.3 percent of the total. Only 3.178 housing units were vacant, representing 9.7 percent of the total units. There were 2,137 seasonal, recreational or occasional housing units. The homeowner vacancy rate was only .9 percent for 2001 and the rental vacancy rate was 4.4 percent. Brick Township has 24,605 owner-occupied housing units and 4,906 renter-occupied units.

3.1.6 Aesthetic and Visual Resources

The general areas of the F&L Abandoned Lagoons site have a variety of habitats that are pleasurable to view, ranging from tidal marshes to dense areas of small trees. Views at both of the lagoons are somewhat restricted, however, by the high, steep piles of excavated sandy material and scrubby vegetation on most sides. The primary aesthetic/visual resources in the area, large expanses of tidal marsh and the open water of Barnegat Bay, are not at all visible from any parts of the lagoons.

3.2 BAYVILLE ABANDONED LAGOON

3.2.1 Physical Setting

Bayville Abandoned Lagoon is located in Berkeley Township off the south side of Bayview Avenue east of Bayville, about 3,360 feet to the east of the intersection with Amherst Drive. As mapped, it comprises a total of approximately 30 acres. From local anecdotal information, the lagoon was apparently dug by developers in the early-to-mid 1960s and was never used. From its setting within the native tidal marsh, it is apparent that the lagoon was dug entirely from the native tidal marsh. The lagoon consists of a roughly key-shaped east-west channel, with one small half-round side branch that is connected to the main channel by an area of (undredged) shallow water (see Figure 3-3). The lagoon is approximately 13 feet deep in the center.

3.2.1.1 Physiography and Topography

Barnegat Bay watershed topography varies from rolling to flat. The Atlantic Coastal Plain rises from sea level along the coast to an altitude of about 200 feet in the northwest corner of Ocean County (USACE 2001).

The terrain in the immediate vicinity of the site is flat (the view is obscured, however, in some areas of the site owing to dense phragmites). According to early 2002 preliminary surveys performed at the Bayville abandoned lagoon site by Andrews, Miller & Associates, vertical elevations vary from about 0.28 to 0.80 feet NAVD over the tidal marsh in the western part of the site to over 10 feet on the large man-made fill pile in the south-central part of the site (AMA 2002).

3.2.1.2 Climate

The climate in Ocean County, New Jersey is continental in nature. Winter temperatures average about 33º Fahrenheit (F), with an average county-wide minimum temperature of 24ºF. The average summer temperature is about 72ºF, with an average daily maximum temperature of 83ºF. Precipitation in the county is well distributed throughout the year; the growing season extends from April through September. About 52 percent of the average annual precipitation, equaling approximately 24 inches, falls during the growing season (USACE 2001).

3.2.1.3 Infrastructure

The Bayville Abandoned Lagoon site is undeveloped and contains no paved roads, buildings, power facilities, rights-of-way, or other anthropogenic infrastructure. A two-branched, narrow dirt access road exists from Bayview Avenue to the southern parts of the site; one branch extends to Barnegat Bay, and the other extends to the base of the large fill pile in the southern part of the site.

Figure 3-3 Bayville Abandoned Lagoon (Scale 1" – 200')

3.2.2 Environmental Setting

3.2.2.1 Land Use, Ownership, Management Plans

The Bayville Abandoned Lagoon site is owned by Ocean County and is included within their Ocean County Natural Lands Trust system. The site is currently designated by the Ocean County Natural Lands Trust as a passive recreational facility. A dirt road leads from Bayview Avenue through the site; a side-branch leads down to the Bay, where small boats can be launched from the end of the road. In 2002 the land managers installed a locked gate at the Bayview Avenue entrance. According to observations from site visits prior to installation of the gate, anglers and hunters occasionally used this site, as several anglers were observed fishing in the Bay adjacent to the site. Additionally, several hunting blinds (apparently for duck hunting) were present along the Bay to the southwest of the site. The site has also been used in the past for illegal dumping. Because of its relative remoteness and accessibility (access is not easy by vehicles, because of protruding trees and shrubs), many demolition materials (bricks, roofing shingles, concrete, etc.) were dumped along both sides of the dirt road.

3.2.2.2 Fisheries

Seining was performed in two locations to assess the fish population of the lagoon portion of the Bayville Abandoned Lagoon site. Results are given in Table 3-4. The seine used was a 75-foot-long, 8-foot-wide net; seining was done in shallow shelves off the northern-most part of area 7 where it meets area 1, and at the southwestern end of the lagoon. Many small adult and juvenile fish were captured with the seine. It must be noted, however, that these fish were caught only on the shallow shelves at the edges of the deep water. No gill netting was performed to sample the deeper habitats at the Bayville abandoned lagoon because the site is currently isolated from the tidal waters of Barnegat Bay. Deepwater habitats at the site likely support few fish because of poor water quality, particularly low levels of dissolved oxygen.

Table 3-4 Combined results of seining in shallow shelf areas (averaging about 6 feet deep) in two locations at the Bayville Abandoned Lagoon site, on 27 June 2000. Seining was not performed in the deep waters of the Bayville Abandoned Lagoon site (as originally presented in Harriott and Southerland 2001) because it is isolated from the tidal waters of Barnegat Bay. Deepwater habitats at the site likely support few fish because of poor water quality, particularly low levels of dissolved oxygen.

Scientific Name	Common Name	Notes
Fundulus heteroclitus	Mumichog	abundant (>100 total)
Fundulus majalis	Striped killifish	abundant
Menidia menidia	Atlantic silverside	abundant
Cyprinodon variegatus	Sheepshead minnow	several
Apeltes quadracus	Fourspine stickleback	several
Gobiosoma bosc	Naked goby	one individual
Calinectes calinectes	Blue crab	five small juveniles and several

		large adults
Palaemontes pugio	Grass shrimp	abundant

The Bayville Abandoned Lagoon site is adjacent to a large geographic area of Barnegat Bay mapped as EFH; no EFH is mapped as part of the site. In its guide to EFH designations in the northeastern United States, NMFS provides a comprehensive summary of EFH designations completed by the New England Fishery Management Council, the Mid-Atlantic Fishery Management Council, the South Atlantic Fishery Management Council, and the NMFS, pursuant to the Magnuson-Stevens Fishery Conservation and Management Act (Act). The 1996 amendments to the Act strengthened the ability of NMFS to protect and conserve the habitat of marine, estuarine, and anadromous finfish, mollusks, and crustaceans. This habitat is broadly defined to include "those waters and substrate necessary to fish for spawning, breeding, feeding, or growth to maturity" (NMFS 1999). Under the Act, the NMFS must coordinate with other Federal agencies that could adversely affect EFH. In turn, NMFS must provide recommendations to Federal and State agencies on such activities to conserve EFH. These recommendations may include measures to avoid, minimize, mitigate, or otherwise offset adverse effects on EFH (NMFS 1999).

3.2.2.3 Benthic Community

There were no benthic invertebrate samples specifically taken at any of the six sites considered under this project. There are data, however, on benthic communities present in the southern part of the Barnegat Bay study area that may be similar to the communities in other tidal sites. Because this abandoned lagoon is isolated from tidal waters, the existing benthic community is likely less abundant and diverse (especially in deep water). However, the benthic community expected to colonize a restored site would be similar to the Bay communities, because tidal connections would be restored. The Barnegat Bay benthic data were obtained as part of the feasibility study for dredged holes restoration in Barnegat Bay (Scott and Kelley 1999; USACE 2001). The benthic communities at the dredged holes sites are in the same geographic region and in similar estuarine habitats as those being considered under this feasibility study. Therefore, as a basis for later evaluation of potential effects on the benthic communities at the six sites, the following benthic data from studies at the dredged holes sites are presented as likely existing conditions.

Dredged Holes Benthic Study Results. Benthic macroinvertebrates were sampled in the spring and summer to evaluate recruitment and community conditions within each hole. The spring survey (conducted on May 26, 1999) was used to determine whether recruitment at various depths within the dredged holes was different than recruitment at naturally occurring depths. A summer benthic survey (conducted on August 4 and 5, 1999) was used to evaluate benthic community conditions during a period when dissolved oxygen stress was expected to be the highest.

Two depth strata (deep and intermediate) were sampled within each hole to determine if there was a depth-related change in benthic community characteristics. Deep samples ranged from 16

to 33 feet deep (with a mean of 24.5 feet) and intermediate samples ranged from 6 to 15 fee deep (with a mean of 10.2 feet). Reference sites immediately adjacent to each hole were sampled to estimate the benthic community characteristics that occur naturally in the shallow waters of Barnegat Bay (shallow samples ranged from 2.5 to 5 feet with a mean of 3.3 feet).

Benthic samples were collected with a 0.044-m^2 stainless steel Young grab sampler. The benthic samples were sieved in the field using a 0.5-mm mesh screen. The material retained on the screen was bottled and preserved in a 10% buffered formalin solution stained with rose bengal.

The community composition of each hole and surrounding shallow areas were similar to each other, between seasons, and between the various depths. In general, arthropods, specifically amphipods (small shrimp type crustaceans) and polychaete worms dominated the benthic community. This was true in both seasons, as well as at the different depths. The numerically dominant amphipods were in the genus *Ampelisca* spp., while the numerically dominant polychaetes were in the Capitellidae family (i.e., *Mediomastus ambiseta* and *Capitella capitata*). In addition, the majority of the epifaunal species collected from the area were amphipods.

Diversity was the greatest in the shallow habitats. Diversity in the deepest areas was extremely low in both seasons, as intermediate depths also had depressed diversity.

The number of large taxa collected in the samples was also examined, and for this summary, large taxa were defined as species with lengths greater than 2 cm. Sites containing many large individuals generally suggest the presence of a long-lived, established benthic community subjected to little stress. The shallow areas contained numerous large taxa while the intermediate area contained some large taxa. No large taxa were collected from the deep areas. The shallow areas near the two dredged holes are highly productive areas with high diversity, abundance, and biomass of benthic organisms. On the other hand, the benthic communities within each hole, in both the intermediate and deep areas, are clearly depressed compared to the surrounding shallow areas. Though the intermediate areas support a benthic community, and in some cases support high numbers of amphipods, all measures of benthic community health (including diversity, abundance, and biomass) were less than those found at nearby areas with "natural" depths. The deepest areas of each hole were essentially azoic in the summer and spring recruitment was extremely depressed.

Regression analysis indicated that there was a relatively strong relationship between benthic community condition and depth. Samples collected from the deepest habitats resulted in essentially no organisms, while the intermediate and shallower depths showed strong increases in all three benthic measures. While a high degree of variation in total abundance and biomass of benthic organisms was observed in the shallow reference samples, the data suggest that filling the holes to reference site depths would have the greatest net benefit to benthic community productivity. This is particularly true for diversity as the shallow water sites consistently yielded higher numbers of species. At the same time, evidence that fish use the intermediate depths, and that benthic communities are productive at such depths, argue for the intermediate depth as the best choice for overall ecological improvement.

3.2.2.4 Other Wildlife

Other wildlife and their signs (tracks, scats, calls, and other identifiable physical evidence) observed at the site while conducting the field studies were all birds, including sharp-tailed sparrow (*Ammospiza caudacuta*), marsh wren (*Cistothorus palustris*), American egret (*Casmerodius albus*), and snowy egret (*Egretta thula*). Most of the birds were observed along the southern and western boundaries of the site, adjacent to the existing tidal marsh, and not in its interior. Because of the lower salinity relative to that of the adjacent Bay, and the presence of SAV, it is possible that the shallow areas of the lagoon (i.e., Figure 3-3, area 7) could be occasionally used by aquatic birds (e.g., ducks and geese) for resting and feeding. No birds were actually observed, however, during several late fall and early winter visits to the site. Because of the relatively small size of the lagoon (less than 4 acres) and the fact that SAV only occurs within area 7 (less than 2 acres), it is unlikely that this is a significant resource for aquatic birds. It should also be noted that no signs of diamondback terrapins were observed anywhere on or adjacent to the site. This may be owing to the fact that the site is isolated from the tide and no appropriate habitats (i.e., open or semi-open and sandy) are present.

3.2.2.5 Vegetation and Land Cover

Existing vegetation and land cover were mapped at the Barnegat sites during the environmental testing studies conducted for the project (Harriott and Southerland 2001); this information is subsequently presented on figures in Chapter 5 of this report. The primary vegetation type on the Bayville Abandoned Lagoon site as mapped is tidal marsh (area 2). This large area of tidal marsh was included as part of the site so that it could be properly accounted for and protected during future restoration efforts. The tidal marsh is relatively undisturbed, and its principal species are salt marsh cordgrass (*Spartina alterniflora*), salt hay (*Spartina patens*), marsh spike grass (*Distichlis spicata*), and a small amount of high tide bush (*Iva frutescens*). In addition, five parcels within the marsh in the western part of the site are dominated by phragmites. From observations during the field studies it is apparent that these parcels may be the result of several inches of fill in these areas (just enough to isolate them from the saline tide).

Most of the areas of fill on the site possess a cover of scrubby, upland deciduous forest (areas 2). The forest is characterized by locally dense areas of small trees and shrubs; other areas are open and less dense. The largest trees present are red maple (*Acer rubrum*), and black cherry (*Prunus serotina*); these are scattered, and are a maximum of about 8 inches diameter at breast height (dbh). The average size of the trees on site is about 4 to 6 inches dbh. Other tree species in the forest include American holly (*Ilex opaca*), sassafras (*Sasafrass albidum*) and white mulberry (*Morus alba*). Shrubs and woody vines observed include smooth sumac (*Rhus glabra*), staghorn sumac (*Rhus typhina*), bayberry (*Myrica pensylvanica*), Virginia creeper (*Parthenocissus quinquefolia*), poison ivy (*Toxicodendron radicans*), and Japanese honeysuckle (*Lonicera japonica*).

Other parts of the site possess dense, monotypic covers of phragmites in wetlands (areas 3). Most of these parcels contain only small amounts of fill and are wetlands, but appear to be

isolated from the tide. One small area of phragmites on uplands (area 6) is located immediately west of the intersection of the dirt road with Bayview Avenue.

3.2.2.6 Threatened and Endangered Species

According to the New Jersey Natural Heritage database, and the USFWS, there are no records of state or Federal Threatened or Endangered species or other species of special concern on the Bayville Abandoned Lagoon site.

3.2.2.7 Wetlands

As mapped in the Barnegat Bay Ecosystem Restoration Environmental Testing and Restoration Proposals report (Harriott and Southerland 2001), a total of approximately 21.14 acres of freshwater and tidal wetlands exist at the Bayville abandoned lagoon site. Vegetated tidal wetlands at the Bayville Abandoned Lagoon site are dominated by tidal (spartina) marshes (10.18 acres). Vegetated freshwater wetlands are dominated by phragmites marsh (5.00 acres). Other vegetated wetlands at the site include a shallow open water area of the lagoon that contains a significant amount of submerged aquatic vegetation (SAV) (1.98 acres). The deep, unvegetated open water of the lagoon proper comprises the remainder of site wetlands (3.98 acres).

The Bayville Lagoon was excavated by developers in the late 1960s, apparently for development, but was never used. When the lagoon was dug, materials were deposited in some areas of the tidal marsh, creating several berms on the tidal marsh. Most of the tidal marshes at the Bayville Abandoned Lagoon site are relatively undisturbed by humans, with the exception of several small mosquito ditches. As previously indicated, the principal species on the tidal marsh are salt marsh cordgrass, salt hay, and marsh spike grass; a small amount of high tide bush is also present along the edges of the marsh.

The six parcels of phragmites in the western part of the site likely exist because a small amount of dredged material was sidecast here in separate piles. The piles slightly raised the marsh, allowing the phragmites a respite from the tide; it was able to colonize these small areas. The phragmites in two small parcels of phragmites marsh on the eastern end of the site also appear to have colonized small amounts of fill material, isolating these areas from the tide.

3.2.2.8 Air Quality

There are several air monitoring stations in southeastern New Jersey. The Edwin B. Forsythe National Wildlife Refuge, extending along the Ocean County coast, monitors ambient ozone and sulfur dioxide concentration. Carbon monoxide, total particulates, and lead are monitored at an Atlantic City, New Jersey station; another station in Millville, New Jersey monitors nitrogen oxides (USACE 2001).

USEPA has reported that ozone levels within Ocean County persistently exceed national air quality standards, causing the county to be classified as a non-attainment area for ozone. All other pollutants listed by USEPA are currently in attainment status (USACE 2001).

3.2.2.9 Hazardous, Toxic & Radioactive Waste

In accordance with ER 1165-2-132, entitled *Hazardous, Toxic and Radioactive Wastes (HTRW) Guidance for Civil Works Projects*, dated 26 June 1992, investigations must be conducted to assess the existence, nature and extent of HTRW within a project impact area (Comprehensive Environmental Response, Compensation, and Liability Act [CERCLA], 42 U.S.C. > 9601 et seq., as amended). Hazardous substances regulated under CERCLA include "hazardous wastes" under Section 3001 of the Resource Conservation and Recovery Act (RCRA), (42 U.S.C. 6921 et seq.), "hazardous substances" identified under Section 311 of the Clean Water Act (33 U.S.C. 1317); "hazardous air pollutants" designated under Section 112 of the Clean Air Act (42 U.S.C. 7412); and "imminently hazardous chemical substances or mixtures," upon which USEPA has taken action under Section 7 of the Toxic Substance Control Act (15 U.S.C. 2606).

To comply with the HTRW sections as mandated under CERCLA, Environmental Data Resources (EDR) was retained to conduct assessments of the potential presence of hazardous, toxic, or radioactive waste at the six Barnegat sites. Several sources of data were consulted to complete the HTRW evaluation and to determine the potential for encountering on-site hazards. Each assessment by EDR included searches of Federal and state data bases; CERCLIS and NPL data bases; RCRA data bases; the ERNS data base; the CORRACTS data base; the SPL data base; permitted solid waste disposal; state UST and LUST sites; as well as other data sources.

Existing data base information (as well as site observations during the ecological testing field studies) suggests little potential for encountering hazards on the Bayville Abandoned Lagoon site. Of note, however, the EDR report indicates that one adjacent site (within 1/8 mile), owned by AT&T, is classified as "Small Quantity Generator" of hazardous materials. The data, however, indicate that there is no record of any violations, spills, or any problems at the site. It is not known at this time what the nature of the materials are at this adjacent site. In addition, EDR mapped three other sites within ½ to 1 mile of the Bayville Abandoned Lagoon site. These three sites are relatively far from the Bayville Abandoned Lagoon site, and further appear to be only associated with several minor spills. Because of the nature of the proposed restoration, it does not appear likely that these four adjacent sites are likely to have any negative effect on the proposed restoration at the Bayville Abandoned Lagoon site.

3.2.2.10 Water Resources

Surface water quality was measured at several depths in five locations on and immediately off the Bayville Abandoned Lagoon site; Table 3-5 presents results. Several items were of note in the lagoon. First, the salinity is moderate, at about 12 to 13 parts per thousand. Second, the dissolved oxygen levels were very low at depths below the surface layer, probably owing to the depth and the very poor flushing that exists in this lagoon. At an average of only about 2

milligrams per liter (lowest readings at 1.69 mg/L), the lower levels of the lagoon likely do not provide a habitat suitable for many biota.

Table 3-5 Results of water quality testing done at the Bayville Abandoned Lagoon site for the Barnegat Environmental Testing field studies (as originally presented in Harriott and Southerland 2001).

Sampling Location	pH	Salinity (o/oo)	D.O. (mg/L)	Specific Conductivity (mS/cm)	Temp (C°)	Turbidity (NTU)
W1A (SE end of lagoon; surface)	7.42	12.85	7.59	21.49	27.7	22.5
W1B (SE end of lagoon; 2.3 meters)	7.31	12.51	2.24	20.81	19.51	24.1
W2 (middle of lagoon; 3.79 meters)	6.89	13.31	1.69	22.03	15.56	135.2
W3A (W end of lagoon; surface)	7.31	12.87	6.96	20.90	27.01	22.7
W3B (W end of lagoon; 3.17 meters)	7.23	12.93	1.90	21.46	17.69	24.3
W4 (B. Bay, immed. east of site; 0.32 meter)	8.07	23.59	7.86	37.38	28.83	97.4
W5 (small pond, E of dirt road; 0.63 meter)	7.62	16.25	6.60	26.70	30.33	21.4

Water resources on the Bayville Abandoned Lagoon site consist of the deep, open lagoon and two shallow ponds (vegetated with SAV), as well as the open water habitats in the adjacent Barnegat Bay. Very few waterfowl have been observed on the lagoon or the shallow areas during many visits to the site in different seasons, suggesting these habitats are not fully utilized by wildlife. The shallow edge areas of the lagoon, however, appear to provide excellent habitat for juvenile fish, blue crabs, and other aquatic organisms. These organisms, however, are likely restricted to these edge areas of the deep part of the lagoon and the shallow adjacent open water containing SAV. The existing water quality in the deep parts of the lagoon is sub-par, particularly with regard to dissolved oxygen. Data collected from the site indicate that the current levels of dissolved oxygen in the deep parts of the lagoon average only about 2 mg/L, a level insufficient to support many aquatic species.

3.2.2.11 Geology and Soil

The dredged material piles resulting from the excavation of the lagoon were not measured during the environmental testing phase of the work, but their extents and volumes were estimated based on several field visits (Harriott and Southerland 2001). The steep fill pile at the terminus of the dirt road varies from about 15 to 18 vertical feet above the existing marsh; it is about 250 feet long and 100 feet wide. Conversely, the existing dirt road was measured in several places; it is

an average of 35 feet wide, and an average of 3 to 5 vertical feet above the existing adjacent marsh. The fill areas and road are composed of a coarse sand-silt mixture. It was observed during the field studies for environmental testing that the Bayville Abandoned Lagoon site tidal wetlands possess a deep, black organic substrate, typical of tidal wetland habitats throughout the Barnegat Bay region.

A simplified bathymetric survey was performed to determine the approximate depths, bottom contours and substrates of the Bayville Abandoned Lagoon site. Stations were evenly distributed throughout the lagoon (middle and sides). All bathymetric stations were sampled for depth and dominant substrate; results are presented in Table 3-6.

Table 3-6 Results of bathymetric survey performed at the Bayville Abandoned Lagoon site for Barnegat environmental testing (as originally presented in Harriott and Southerland 2001).

Station #	Water depth (feet)	Substrate	Notes
A	15.3	fine silt	black, odorous muck
B	8.0	fine silt	black, odorous muck
C	1.5	fine silt	black, odorous muck
D	12.0	fine silt	black, odorous muck
E	1.5	fine silt	black, odorous muck
F	13.0	fine silt	black, odorous muck
G	12.2	fine silt	black, odorous muck
H	14.3	fine silt	black, odorous muck
I	12.3	fine silt	black, odorous muck
J	16.3	fine silt	black, odorous muck

3.2.3 Recreational Facilities

Vehicle access to the Bayville Abandoned Lagoon site is now blocked with a locked gate; access is by foot only from Bayview Avenue. There are no recreational facilities established on the Bayville Abandoned Lagoon site, however during field visits several anglers were observed fishing in the Bay adjacent to the site (these observations were prior to installation of the locked gate, however). Hunters have also established several blinds for hunting (presumably waterfowl) in the marsh adjacent to the Bay. No blinds or other signs of hunting have been observed immediately adjacent to the lagoon. Few other recreational facilities are apparently available at the Bayville abandoned lagoon site.

3.2.4 Cultural Resources

In preparing the draft Feasibility Study, USACE has consulted with the NJ SHPO and other interested parties in order to assess the potential for historic properties in the project area as required under Section 106 of the National Historic Preservation Act of 1966, as amended, and its implementing regulations, 36 CFR Part 800. Section 106 consultation with the NJ SHPO is

continuing and will be concluded prior to any project construction activity. The following brief summary outlines several cultural resources investigations conducted by USACE in the Barnegat Bay area and provides a very general history of the region.

USACE has conducted several cultural resources investigations in the Barnegat Bay region in preparation for possible construction of flood control measures in the Manasquan River Basin, proposed ocean shoreline protection projects along the barrier islands between Manasquan Inlet and Long Beach Island, and maintenance activities associated with the operation of Barnegat Bay Inlet. USACE conducted a Phase 1A cultural resources investigation in 1978 in preparation for inlet dredging, shoreline sand placement and new jetty construction at Barnegat Inlet (Gilbert/Commonwealth, 1979). Researchers identified 13 historic properties in the project area vicinity utilizing records background research and on site field reconnaissance. No prehistoric sites were identified.

USACE has completed four cultural resources studies in the northern Barnegat Bay area. The first study, entitled A Phase 1A Cultural Resources Investigation of the Manasquan River Basin, Monmouth and Ocean Counties, New Jersey (Hunter Research Inc. 1993), generated a cultural resource database for the Manasquan River watershed as a planning tool in the development of flood control improvements in the 80 square mile basin. The second investigation entitled Phase 1A Cultural Resources Investigations, Manasquan Inlet to Barnegat Inlet, Ocean County, New Jersey (Hunter Research Inc. 1997) compiled existing cultural resource information from archival and historic map sources to identify known and expected historic properties in that coastal area. In addition, a low-tide pedestrian archeological survey was conducted along the shoreline in the northern portion of the project area from Manasquan Inlet to the northern boundary of Island Beach State Park. One possible shipwreck site was identified in the near-shore surf zone.

In the third study, entitled Phase I Submerged and Shoreline Cultural Resources Investigations, Manasquan Inlet to Barnegat Inlet, Ocean County, New Jersey (Dolan Research, Inc. 2001), researchers investigated proposed project offshore borrow areas, submerged near-shore locations, and terrestrial shoreline areas utilizing magnetometer, side-scan, and bathymetric data collection techniques. Nineteen remote sensing targets exhibiting shipwreck characteristics were identified in the submerged portion of the near-shore area. In the fourth study, entitled Supplemental Phase I Submerged Cultural Resources Investigations, Borrow Area "B", Manasquan Inlet to Barnegat Inlet, Ocean County, New Jersey (Dolan Research, Inc., 2001), researchers conducted remote sensing in an expanded portion of offshore Borrow Area B. No significant cultural resources were identified.

USACE completed two cultural resources investigations in the southern Barnegat Bay area in association with proposed ocean shoreline protection activities on Long Beach Island. The first study, entitled Phase I Submerged and Shoreline Cultural Resources Investigations and Hydrographic Survey, Long Beach Island, Ocean County, New Jersey (Hunter Research, Inc., Dolan Research Inc. and Enviroscan, Inc., 1998) discusses the results of near-shore tidal and offshore borrow area investigations. Eleven underwater targets exhibiting shipwreck characteristics were identified. In a follow-up investigation entitled Supplemental Phase IB and

Phase II Cultural Resources Investigations, New Jersey Atlantic Coast, Long Beach Island, Ocean County, New Jersey (Dolan Research, Inc., 2001), researchers discuss the investigation of the eleven targets identified in the previous study. Two of the targets were found to be shipwrecks that appear to meet the minimum eligibility requirements for listing on the National Register of Historic Places. The following historical summary is taken directly from the above referenced reports.

The majority of documented prehistoric sites in the Barnegat Bay vicinity are from the Woodland Period and are concentrated around the tidal estuaries of the Barnegat Bay and Manasquan Rivers. Notable features of the archaeology of this area are shell-middens and Native American burials. However, no burials are recorded from the Atlantic shoreline itself. Three prehistoric sites have been documented in Point Pleasant Beach and Ortley Beach, Dover Township. The recent discovery of a Paleo-Indian fluted point in Island Beach State Park is a significant find from this early period along the New Jersey shore. Despite a statewide survey of archaeological resources conducted in the early part of this century and more recent cultural resources investigations, no confirmed prehistoric sites have been identified within the tidal zones of the Bay or ocean shorelines on Long Beach Island itself.

The increasing population of the area in the third quarter of the 19th century led to the establishment of a number of incorporated communities from 1886 onward. These include Bay Head Borough (1886), Harvey Cedars (1894), Island Beach Borough (1933-1965), Lavallette Borough (1887), Mantoloking Borough (1911), Point Pleasant Beach Borough (1886), Seaside Heights Borough (1913) and Seaside Park Borough (1898).

A review of the historic map coverage of the project area documents the development of the shore from a barely-inhabited barrier island to a fully-developed resort community. At the time of the 1776 Holland Map no settlements or isolated dwellings were shown on the barrier islands. The mainland area is described as “Sandy Barren Deserts”, and only one road reached the coast in the project area, opposite Barnegat Inlet. A second inlet, identified as “New Inlet” lay north of Barnegat Inlet in the area of the present Toms River. By 1850, eight individual structures, five of them with owner's names attached, are shown on the island. The New Inlet of 1776 was subsequently renamed Cranberry Inlet but is marked as closed on the 1850 map. It had apparently filled in by about 1812.

The 1872 Beers map shows a minor increase in recreational use of the region. The development of Point Pleasant continues and three roads lead to the shoreline from the Manasquan River area. Numerous hotels and boarding houses shown include the Ocean Hotel and Cook property near the Manasquan River, Chadwick's Hotel in Chadwick, an unnamed hotel in the present Seaside Heights, and Reed's Hotel within the present limits of Island Beach State Park. Three life saving stations are also shown.

An 1878 map shows two planned seaside resort communities in the project area, Lavallette and Seaside Heights, and six life-saving stations, all numbered on the national system and given identifying names. By 1883, a railroad connection ran down the Island from the north as far down as Seaside Park, from where it crossed Barnegat Bay south of Toms River. Since the late

19th century much of the remainder of the coast has been developed. Island Beach State Park was set aside prior to World War II, during which time this area was used for missile development and testing. The park was formally opened in 1959.

Although Barnegat Bay was utilized by local anglers and sportsmen throughout the 19th and 20th centuries, the majority of commercial shipping occurred in the shipping lanes running adjacent to the island's Atlantic Ocean shoreline. Over the centuries numerous ships have been wrecked along New Jersey's 127-mile-long coast line and a great number occurred specifically off Long Beach Island. By the first quarter of the 19th century, volunteer life saving stations had been established in many locations along New Jersey's coast. The first Federal assistance came in 1823, when an appropriation was made for the construction of a lighthouse at Cape May. Following the construction of the Cape May Lighthouse, a series of lighthouses were constructed along the New Jersey shoreline, including the Barnegat Lighthouse Tower and the Little Egg Harbor Light.

Between 1848 and 1878, a total of at least 125 shipwrecks have been documented off the Atlantic coastline between Barnegat Inlet and Manasquan Inlet. A single historic vessel has been archaeologically recorded in the project area. In 1988, the remains of a boat were located at the intersection of the southbound lane of Route 35 with Fielder Avenue in Ortley Beach, about 250 yards west of the shore. The vessel was undated.

The first Federal appropriation for life saving stations in any state occurred in 1848 when $10,000 was set aside to provide for life boats, rockets and the construction of eight life saving stations on the New Jersey coast between Sandy Hook and Little Egg Harbor. The observation towers, small wooden buildings and tiny boats associated with these posts were the only means of defense against the loss of human lives. Initially, there were two life saving stations on Long Beach Island. The first was located at Harvey Cedars and the second near Bond's Hotel. In 1870, congress provided the first funds for a professional United States Life Saving Service and in 1886, the Federal government inaugurated the policy of manning all stations with paid crews. Lovelady's Island, Harvey Cedars and Long Beach Life Saving Stations still stand today in their original locations. The 1898 U.S. Life-Saving Station #14 at Island Beach State Park is listed on the National Register of Historic Places and the Point Pleasant Beach Coast Guard Station is considered eligible for listing.

3.2.5 Socioeconomic Environment

The Bayville Lagoon is located in Berkeley Township. This area was formerly a primary summer/ vacation area. There has been a growth of senior citizen developments and a change from vacation to year-round living. The township is no longer a resort/tourism area. Berkeley was incorporated in 1875 and consists of an area that is 41.9 square miles. The population was 37,319 in 1990 and increased by 7.2 percent in 2000, to 39,991.

3.2.6 Aesthetic and Visual Resources

The Bayville Abandoned Lagoon site is a fairly remote area that is occasionally used by local anglers and hunters. The existing tidal wetlands are large, with little disturbance, providing pleasant views over the marsh to Barnegat Bay. Unfortunately this site has seen a large amount of illegal dumping. During field visits, many areas where found with piles of dumped demolition materials, including bricks, shingles, and concrete. A large portion of these materials were apparently removed by Ocean County when the locked gate was installed at Bayview Avenue in 2002. It is likely that the locked gate will prevent future illegal dumping at the site. Access to the site, however, will be restricted to foot travel only.

3.3 OYSTER CREEK

3.3.1 Physical Setting

The Oyster Creek site is a former dredged material disposal site located in Lacey Township on the left bank of Oyster Creek, at its confluence with Barnegat Bay. The site is immediately south of Orlando Drive along the southern end of the Forked River Beach community. Oyster Creek is shaped like a long, curved rectangle (longer east to west than north to south), and comprises a total of approximately 111 acres (see Figure 3-4). The site is composed of three large sections that are divided by a series of berms and ditches. The ditch system in the eastern and central sections flows along the peripheries and is substantial (in places the ditches are nearly 20 feet wide); these were presumably created to drain the dredged materials after deposition on the site. The ditches are isolated and are not connected to the tide.

3.3.1.1 Physiography and Topography

Barnegat Bay watershed topography varies from rolling to flat. The Atlantic Coastal Plain rises from sea level along the coast to an altitude of about 200 feet in the northwest corner of Ocean County (USACE 2001).

The terrain in the immediate vicinity of the site is flat (the view is obscured, however, over much of the site owing to the dense phragmites). According to preliminary surveys performed in early 2002 at the Oyster Creek site by Andrews, Miller & Associates, vertical elevations vary from about 0.50 feet NAVD near the eastern section ponds to about 8 feet at the high point in the western part of the site (AMA 2002).

3.3.1.2 Climate

The climate in Ocean County, New Jersey is continental in nature. Winter temperatures average about 33º Fahrenheit (F), with an average county-wide minimum temperature of 24ºF. The average summer temperature is about 72ºF, with an average daily maximum temperature of 83ºF. Precipitation in the county is well distributed throughout the year; the growing season extends from April through September. About 52 percent of the average annual precipitation, equaling approximately 24 inches, falls during the growing season (USACE 2001).

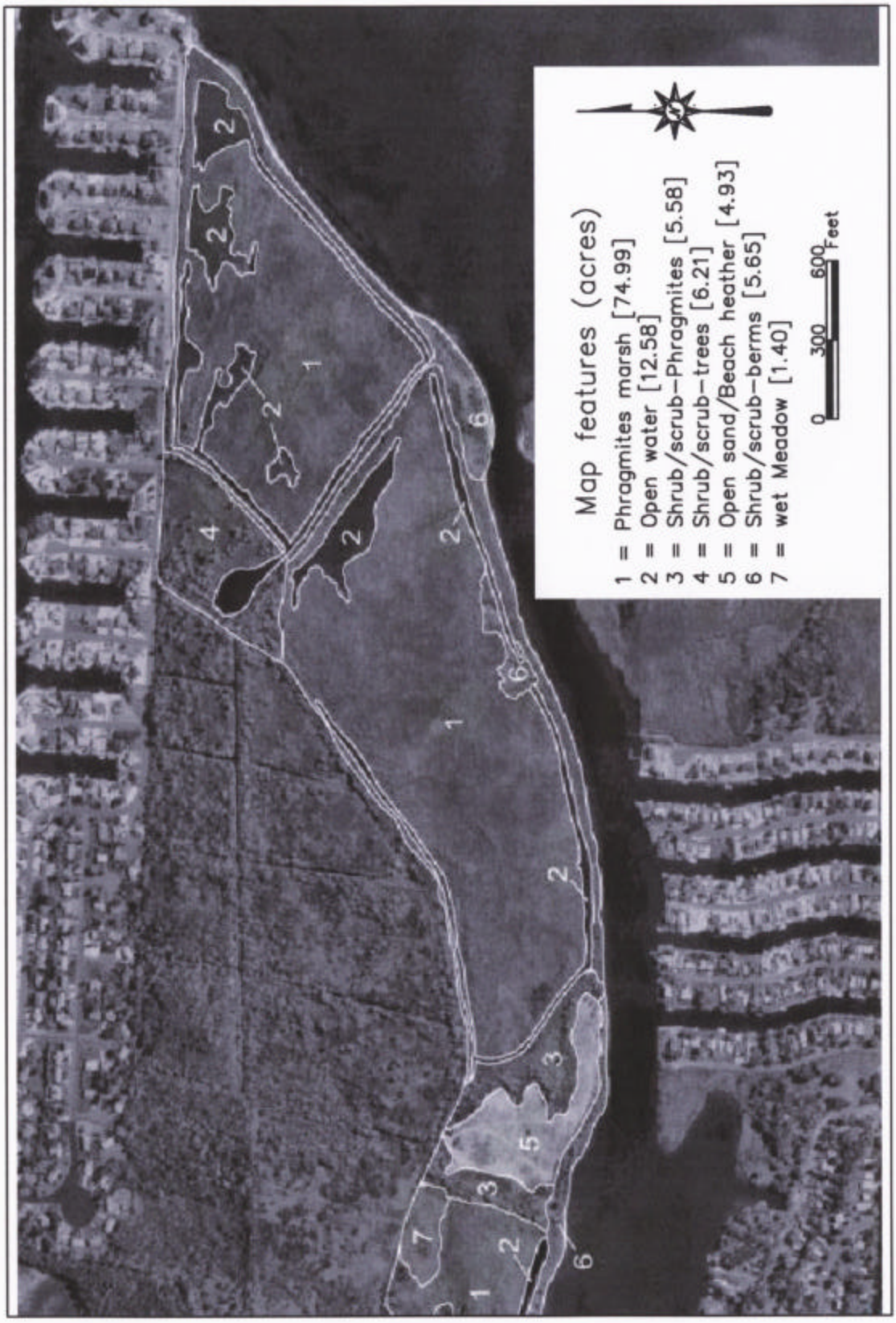


Figure 3-4 Oyster Creek (Scale 1" – 600')

3.3.1.3 Infrastructure

The Oyster Creek site is undeveloped and contains no paved roads, buildings, power facilities, utility rights-of-way, or other anthropogenic infrastructure (with the exception of several piped metal culverts that connect the extensive deep ditch system). A number of narrow dirt access paths exist throughout the eastern section of the site; access to the paths is blocked to motor vehicles at Orlando Drive by a number of large, narrowly spaced concrete pillars. Other access to the paths is difficult because of the wide, deep ditch system that acts as a "moat" in many parts of the site. Remains of a dilapidated wooden bulkhead exist along the left bank of Oyster Creek near its mouth.

3.3.2 Environmental Setting

3.3.2.1 Land Use, Ownership, Management Plans

The Oyster Creek site is owned by Amergen Energy Company. The site has been used for the disposal of dredged material within the past 20 years. This site is closest to existing residences (Forked River Beach lagoon community) on its northern end, where it meets Orlando Drive.

Based on observations during field visits to the site, and from conversations with members of the local community, there is some recreational use of the site by the public. Most of this activity appears to include people walking along the existing system of dirt roads. Despite the concrete barriers at the site entrance on Orlando Drive, small motor vehicles, such as motorcycles and all-terrain vehicles, still access the site. The site is posted with prominent "no trespassing" signs along its entire boundary with Orlando Drive.

There are no known definite management plans for the Oyster Creek site. If the Oyster Creek nuclear plant is de-commissioned, however, dredging of Oyster Creek will likely be necessary to allow for access by heavy equipment for removal of the reactor. The resulting dredged materials would likely be placed on the Oyster Creek site. Because of the large size of the site, and the fact that the restoration actions would only take place on part of the site, however, it is possible that there would still be sufficient area left for placement of the dredged material from the de-commissioning.

3.3.2.2 Fisheries

No fisheries data were collected from this site. It is expected that fish species common to Barnegat Bay would utilize this site where native vegetation and natural hydrologic patterns exist (BBEP 2001). In its current degraded condition, the freshwater or brackish ditches probably support a poor fish community, at best.

The Oyster Creek site is adjacent to a large geographic area of Barnegat Bay mapped as EFH; no EFH is mapped as part of the site. In its guide to EFH designations in the northeastern United States, NMFS provides a comprehensive summary of EFH designations completed by the New

England Fishery Management Council, the Mid-Atlantic Fishery Management Council, the South Atlantic Fishery Management Council, and the NMFS, pursuant to the Magnuson-Stevens Fishery Conservation and Management Act (Act). The 1996 amendments to the Act strengthened the ability of NMFS to protect and conserve the habitat of marine, estuarine, and anadromous finfish, mollusks, and crustaceans. This habitat is broadly defined to include "those waters and substrate necessary to fish for spawning, breeding, feeding, or growth to maturity" (NMFS 1999). Under the Act, the NMFS must coordinate with other Federal agencies that could adversely affect EFH. In turn, NMFS must provide recommendations to Federal and State agencies on such activities to conserve EFH. These recommendations may include measures to avoid, minimize, mitigate, or otherwise offset adverse effects on EFH (NMFS 1999).

3.3.2.3 Benthic Community

There were no benthic invertebrate samples specifically taken at any of the six sites considered under this project. There are data, however, on benthic communities present in the southern part of the Barnegat study area that may be comparable to the communities in other tidal sites. These data were obtained as part of the feasibility study for dredged holes restoration in Barnegat Bay (Scott and Kelley 1999; USACE 2001). The benthic communities at the dredged hole sites are in the same geographic region and in similar estuarine habitats as those being considered under this feasibility study. In general, arthropods, specifically amphipods (small shrimp type crustaceans) and polychaete worms dominated the benthic community. This was true in both seasons, as well as at the different depths. The numerically dominant amphipods were in the genus *Ampelisca* spp., while the numerically dominant polychaetes were in the Capitellidae family (i.e., *Mediomastus ambiseta* and *Capitella capitata*). In addition, the majority of the epifaunal species collected from the area were amphipods.

3.3.2.4 Other Wildlife

Wildlife and their signs (tracks, scats, calls, and other identifiable physical evidence) observed at and near the Oyster Creek site while conducting the site selection and testing phase field studies included white-tailed deer (*Odocoileus virginianus*), osprey (*Pandion haliaetus*), mute swan (*Cygnus olor*), spotted sandpiper (*Actitus macularia*), northern black racer (*Coluber constrictor constrictor*), and black rat snake (*Elaphe obsoleta obsoleta*). A group of about five deer were observed in the scrub-shrub area in the northwestern part of the site (Figure 3-4, area 4); based on the large amount of scrubby early forest habitats (non-phragmites) available off-site to the north and west, and probable heavy restrictions on area hunting, it is surmised that there is a relatively large deer population present.

An osprey was observed flying over Oyster Creek toward the south shore carrying a fish; no active or inactive nests were observed on or anywhere near the site. A pair of mute swans were observed in the northeastern-most shallow pond in the eastern section of the site. The swans flushed upon approach to the pond; it is not known how they use the resource (e.g., temporary use, feeding, breeding, etc.). No other birds were observed on any of the ponds. This may relate to the apparently poor water quality of the ponds (i.e., few food resources), and the fact that they are virtually enclosed by dense, tall phragmites (i.e., poor visibility from predators). One spotted

sandpiper was observed along the shoreline at the mouth of Oyster Creek (near some bulkheads there). It is not known whether spotted sandpipers breed in the vicinity, but appropriate habitat could exist off the site along Oyster Creek.

A black rat snake (a 36-inch-long adult) was observed on a narrow shoreline path along Oyster Creek (dense phragmites was present on one side of the path, and the creek was on the other). In addition, a black racer snake (a 28-inch-long adult) was observed along a footpath in the northwestern part of the site; of note was its unusual dark gray coloration (instead of the black typical of this species).

It should also be noted that the deer tick population on parts of the Oyster Creek site was unusually heavy at the time of the environmental testing field studies (field scientists pulled hundreds of ticks off their clothes during the field studies), particularly along the partially overgrown footpath along its northern boundary. This is likely indirect evidence of a large existing small mammal and deer population. One other item of note is that no evidence of red foxes was observed in the large open-sandy area (area 5) in the western part of the site. This is unusual, considering almost every similar habitat on other sites studied (particularly islands) possessed evidence of at least past use. This may be indicative of the apparently heavy current human use of this part of the site (for parties, motorcycle and ATV riding, etc.).

3.3.2.5 Vegetation and Land Cover

Existing vegetation and land cover were mapped at the Barnegat sites during the environmental testing studies conducted for the project (Harriott and Southerland 2001); this information is subsequently presented on figures in Chapter 5 of this report. The primary vegetation type at the Oyster Creek site, particularly in the eastern and central sections of the site, is freshwater phragmites marsh. The entire eastern two-thirds of the site is almost wholly composed of phragmites marsh, small stagnant shallow ponds, and large ditches, with two minor exceptions. Three narrow berm areas near the southcentral and southeastern parts of the central section of the site and along the southern (creek) end of the western section (areas 6), and a small area in the northwestern-most part of the eastern section (area 4) possess shrub-scrub vegetation. Area 6 is dominated by switchgrass (*Panicum virgatum*) and broomsedge (*Andropogon virginicus*); scattered bayberry (*Myrica pensylvanica*) and small red maple (*Acer rubrum*) trees are also present along its margins with the lower areas (i.e., where it meets phragmites or open water). Area 4 is dominated by phragmites on its eastern side; on its western side it possesses a mixture of small red maple, black gum (*Nyssa sylvatica*), black cherry (*Prunus serotina*), sassafras (*Sassafras albidum*), and persimmon (*Diospyros virginiana*) trees, highbush blueberry, switchgrass, and phragmites. The trees on the northwestern side of area 4 were the largest (6 to 8 inches dbh maximum) and most dense (although not sufficiently dense to be considered "forest"). Another scrub-shrub vegetation type that is partly dominated by phragmites exists within areas 3. Principal species in these areas are phragmites, highbush blueberry (*Vaccinium corymbosum*), red maple, and switchgrass. One of the most interesting areas of the site is the open, sandy habitat within area 5, dominated by beach heather (*Hudsonia tomentosa*). The beach heather is densest in the northwestern part of the area; other places in the area are composed of a mixture of open sand and scattered clusters of switchgrass and broomsedge. The

open area is apparently frequented by human visitors, and debris, evidence of campfires, and motorcycle tracks are present throughout.

3.3.2.6 Threatened and Endangered Species

The New Jersey Natural Heritage database indicated that records exist for one plant, awned mountain mint (*Pycnanthemum setosum*) on or near the Oyster Creek site. According to these records, awned mountain mint was observed on or near the site in 1993. This species is not Federal or state listed, but has been assigned a state ranking indicating that it is imperiled in the state because of the small number of known occurrences (6 to 20). It is apparently also relatively rare throughout the rest of its natural range. This species was not observed at the Oyster Creek site during the Barnegat field studies. Prior to the implementation of a final restoration design, the existing populations of awned mountain mint must be thoroughly assessed on this site so they can be avoided and protected.

USFWS recently indicated that an extant population of the Federal candidate and state-listed Endangered bog asphodel (*Narthecium americanum*) is located within one mile of the Oyster Creek site (USFWS 2002). No appropriate habitat apparently exists on or adjacent to the Oyster Creek site, however, for this species.

3.3.2.7 Wetlands

Wetlands were mapped with limited field verification during the environmental testing field studies. As mapped, a total of approximately 99.36 acres of wetlands currently exist at the Oyster Creek site. Refer to the previous Vegetation section for the plant species composition of the wetlands on site. Two-thirds of the Oyster Creek site consists of phragmites marsh. Within this area there are several small, stagnant ponds and ditches that provide only marginal wetland habitats to wildlife. A large area of offsite scrub-shrub and semi-forested wetlands border the site on its northwestern side. This off-site area is grid-ditched, apparently from a historic mosquito-control effort. This area was visited only briefly during the field studies, but because of its mix of species and structure it apparently provides some value to wildlife. This is especially true of the northern part where some larger trees exist and there is relatively little phragmites present.

3.3.2.8 Air Quality

There are several air monitoring stations in southeastern New Jersey. The Edwin B. Forsythe National Wildlife Refuge, extending along the Ocean County coast, monitors ambient ozone and sulfur dioxide concentration. Carbon monoxide, total particulates, and lead are monitored at an Atlantic City, New Jersey station; another station in Millville, New Jersey monitors nitrogen oxides (USACE 2001).

USEPA has reported that ozone levels within Ocean County persistently exceed national air quality standards, causing the county to be classified as a non-attainment area for ozone. All other pollutants listed by USEPA are currently in attainment status (USACE 2001).

3.3.2.9 Hazardous, Toxic & Radioactive Waste

In accordance with ER 1165-2-132, entitled *Hazardous, Toxic and Radioactive Wastes (HTRW) Guidance for Civil Works Projects*, dated 26 June 1992, investigations must be conducted to assess the existence, nature and extent of HTRW within a project impact area (Comprehensive Environmental Response, Compensation, and Liability Act [CERCLA], 42 U.S.C. > 9601 et seq., as amended). Hazardous substances regulated under CERCLA include "hazardous wastes" under Section 3001 of the Resource Conservation and Recovery Act (RCRA), (42 U.S.C. 6921 et seq.), "hazardous substances" identified under Section 311 of the Clean Water Act (33 U.S.C. 1317); "hazardous air pollutants" designated under Section 112 of the Clean Air Act (42 U.S.C. 7412); and "imminently hazardous chemical substances or mixtures," upon which USEPA has taken action under Section 7 of the Toxic Substance Control Act (15 U.S.C. 2606).

To comply with the HTRW sections as mandated under CERCLA, Environmental Data Resources (EDR) was retained to conduct assessments of the potential presence of hazardous, toxic, or radioactive waste at the six Barnegat sites. Several sources of data were consulted to complete the HTRW evaluation and to determine the potential for encountering on-site hazards. Each assessment by EDR included searches of Federal and state data bases; CERCLIS and NPL data bases; RCRA data bases; the ERNS data base; the CORRACTS data base; the SPL data base; permitted solid waste disposal; state UST and LUST sites; as well as other data sources.

Existing data base information (as well as site observations during the ecological field studies) suggests little potential for encountering hazards on the Oyster Creek site. The EDR report also indicates that there are no potential hazards on any directly adjacent properties. Several records of minor, residential-related spills (e.g., one spill of several gallons of hydraulic oil; another minor spill of gasoline, etc.) were mapped by EDR within one-quarter mile of the site. These mapped "contaminated" sites are not likely to have any negative effect on the proposed restoration.

3.3.2.10 Water Resources

Surface water quality was not measured at the Oyster Creek site during the environmental testing field studies because of equipment malfunctions and a limited field schedule. Consequently, because they are not connected to the tide on Oyster Creek, it is assumed that the system of ditches and ponds on the site are all freshwater to brackish (they are likely occasionally flooded by saline Bay water during storm tides). Based on field observations of these features, it is also assumed that these water bodies are relatively shallow, poorly-flushed (i.e., stagnant), and possess relatively low levels of dissolved oxygen. It is, therefore, assumed that the water quality in these surface water features is relatively poor, and of relatively low value to wildlife. Based on other recent available water quality data on the salinity in the vicinity of the site, the salinity near the mouth of Oyster Creek is estimated to be approximately 20 to 25 parts per thousand.

Currently, the only surface water resources existing at the Oyster Creek site are the series of small shallow freshwater-to-brackish ponds in the eastern part of the site, and the large perimeter

ditches. These ponds and ditches are not large enough to be fished or boated recreationally, possess deep, muddy bottoms, and are difficult to access. Water quality is likely poor in the ponds and ditches because of their relative isolation and shallowness. Refer to the subsequent section for an assessment of site groundwater resources.

3.3.2.11 Geology and Soil

Borings and other measurements were taken in many areas of the site to determine the physical nature of the substrate during the field studies. The highest area of the site is in area 5, in the western-most section of the site; this area is approximately 8 to 10 feet above mean high water in Oyster Creek, and is composed of medium to coarse sand. The adjacent areas 3 and area 6 are slightly lower, about 5 to 6 feet above mean high water in the creek (no groundwater was intercepted in these areas). The western-most parcel of area 1 is 2.5 to 3 feet above the creek, and possesses medium sand with a few cobbles; groundwater is about 1 inch from the surface. The large central section of the site (area 1; possessing a dense cover of phragmites; see the Vegetation and Land Cover section, below) is about 2 feet above mean high water in the creek and possesses a coarse sand and cobble substrate. Groundwater was intercepted at about 1 inch from the surface throughout this area. The large eastern-most parcel of the site (also possessing a dense cover of phragmites) is generally the lowest and wettest part of the site overall. Much of this area appears to be about 1 foot or less above mean high water of the creek; the substrate consists of medium sand with a few cobbles. Several small, shallow, stagnant ponds exist within this area; some are isolated, and some connect to the peripheral ditch system (the depth of the ponds could not be positively determined owing to soft, deep substrate and potentially hazardous conditions).

3.3.3 Recreational Facilities

The site is prominently posted with "no trespassing" signs along its entire boundary with Orlando Drive. There is ample evidence in the open, sandy area on the western side of the site (area 5), however, suggesting that it is used by the public for motorcycle riding, hiking, campfires, and various other activities. Signs were also present that indicate this area is also used as a party site for some local youths. There was no evidence suggesting that anglers or boaters use any of the water resources on the site. It is also possible that the high deer tick population might keep some recreational users away from this area.

3.3.4 Cultural Resources

In preparing the draft Feasibility Study, USACE has consulted with the NJ SHPO and other interested parties in order to assess the potential for historic properties in the project area as required under Section 106 of the National Historic Preservation Act of 1966, as amended, and its implementing regulations, 36 CFR Part 800. Section 106 consultation with the NJ SHPO is continuing and will be concluded prior to any project construction activity. The following brief summary outlines several cultural resources investigations conducted by USACE in the Barnegat Bay area and provides a very general history of the region.

USACE has conducted several cultural resources investigations in the Barnegat Bay region in preparation for possible construction of flood control measures in the Manasquan River Basin, proposed ocean shoreline protection projects along the barrier islands between Manasquan Inlet and Long Beach Island, and maintenance activities associated with the operation of Barnegat Bay Inlet. USACE conducted a Phase 1A cultural resources investigation in 1978 in preparation for inlet dredging, shoreline sand placement and new jetty construction at Barnegat Inlet (Gilbert/Commonwealth, 1979). Researchers identified 13 historic properties in the project area vicinity utilizing records background research and on site field reconnaissance. No prehistoric sites were identified.

USACE has completed four cultural resources studies in the northern Barnegat Bay area. The first study, entitled A Phase 1A Cultural Resources Investigation of the Manasquan River Basin, Monmouth and Ocean Counties, New Jersey (Hunter Research Inc. 1993), generated a cultural resource database for the Manasquan River watershed as a planning tool in the development of flood control improvements in the 80 square mile basin. The second investigation entitled Phase 1A Cultural Resources Investigations, Manasquan Inlet to Barnegat Inlet, Ocean County, New Jersey (Hunter Research Inc. 1997) compiled existing cultural resource information from archival and historic map sources to identify known and expected historic properties in that coastal area. In addition, a low-tide pedestrian archeological survey was conducted along the shoreline in the northern portion of the project area from Manasquan Inlet to the northern boundary of Island Beach State Park. One possible shipwreck site was identified in the near-shore surf zone.

In the third study, entitled Phase I Submerged and Shoreline Cultural Resources Investigations, Manasquan Inlet to Barnegat Inlet, Ocean County, New Jersey (Dolan Research, Inc. 2001), researchers investigated proposed project offshore borrow areas, submerged near-shore locations, and terrestrial shoreline areas utilizing magnetometer, side-scan, and bathymetric data collection techniques. Nineteen remote sensing targets exhibiting shipwreck characteristics were identified in the submerged portion of the near-shore area. In the fourth study, entitled Supplemental Phase I Submerged Cultural Resources Investigations, Borrow Area "B", Manasquan Inlet to Barnegat Inlet, Ocean County, New Jersey (Dolan Research, Inc., 2001), researchers conducted remote sensing in an expanded portion of offshore Borrow Area B. No significant cultural resources were identified.

USACE completed two cultural resources investigations in the southern Barnegat Bay area in association with proposed ocean shoreline protection activities on Long Beach Island. The first study, entitled Phase I Submerged and Shoreline Cultural Resources Investigations and Hydrographic Survey, Long Beach Island, Ocean County, New Jersey (Hunter Research, Inc., Dolan Research Inc. and Enviroscan, Inc., 1998) discusses the results of near-shore tidal and offshore borrow area investigations. Eleven underwater targets exhibiting shipwreck characteristics were identified. In a follow-up investigation entitled Supplemental Phase IB and Phase II Cultural Resources Investigations, New Jersey Atlantic Coast, Long Beach Island, Ocean County, New Jersey (Dolan Research, Inc., 2001), researchers discuss the investigation of the eleven targets identified in the previous study. Two of the targets were found to be shipwrecks that appear to meet the minimum eligibility requirements for listing on the National

Register of Historic Places. The following historical summary is taken directly from the above referenced reports.

The majority of documented prehistoric sites in the Barnegat Bay vicinity are from the Woodland Period and are concentrated around the tidal estuaries of the Barnegat Bay and Manasquan Rivers. Notable features of the archaeology of this area are shell-middens and Native American burials. However, no burials are recorded from the Atlantic shoreline itself. Three prehistoric sites have been documented in Point Pleasant Beach and Ortley Beach, Dover Township. The recent discovery of a Paleo-Indian fluted point in Island Beach State Park is a significant find from this early period along the New Jersey shore. Despite a statewide survey of archaeological resources conducted in the early part of this century and more recent cultural resources investigations, no confirmed prehistoric sites have been identified within the tidal zones of the Bay or ocean shorelines on Long Beach Island itself.

The increasing population of the area in the third quarter of the 19th century led to the establishment of a number of incorporated communities from 1886 onward. These include Bay Head Borough (1886), Harvey Cedars (1894), Island Beach Borough (1933-1965), Lavallette Borough (1887), Mantoloking Borough (1911), Point Pleasant Beach Borough (1886), Seaside Heights Borough (1913) and Seaside Park Borough (1898).

A review of the historic map coverage of the project area documents the development of the shore from a barely-inhabited barrier island to a fully-developed resort community. At the time of the 1776 Holland Map no settlements or isolated dwellings were shown on the barrier islands. The mainland area is described as “Sandy Barren Deserts”, and only one road reached the coast in the project area, opposite Barnegat Inlet. A second inlet, identified as “New Inlet” lay north of Barnegat Inlet in the area of the present Toms River. By 1850, eight individual structures, five of them with owner's names attached, are shown on the island. The New Inlet of 1776 was subsequently renamed Cranberry Inlet but is marked as closed on the 1850 map. It had apparently filled in by about 1812.

The 1872 Beers map shows a minor increase in recreational use of the region. The development of Point Pleasant continues and three roads lead to the shoreline from the Manasquan River area. Numerous hotels and boarding houses shown include the Ocean Hotel and Cook property near the Manasquan River, Chadwick's Hotel in Chadwick, an unnamed hotel in the present Seaside Heights, and Reed's Hotel within the present limits of Island Beach State Park. Three life saving stations are also shown.

An 1878 map shows two planned seaside resort communities in the project area, Lavallette and Seaside Heights, and six life-saving stations, all numbered on the national system and given identifying names. By 1883, a railroad connection ran down the Island from the north as far down as Seaside Park, from where it crossed Barnegat Bay south of Toms River. Since the late 19th century much of the remainder of the coast has been developed. Island Beach State Park was set aside prior to World War II, during which time this area was used for missile development and testing. The park was formally opened in 1959.

Although Barnegat Bay was utilized by local anglers and sportsmen throughout the 19th and 20th centuries, the majority of commercial shipping occurred in the shipping lanes running adjacent to the island's Atlantic Ocean shoreline. Over the centuries numerous ships have been wrecked along New Jersey's 127-mile-long coast line and a great number occurred specifically off Long Beach Island. By the first quarter of the 19th century, volunteer life saving stations had been established in many locations along New Jersey's coast. The first Federal assistance came in 1823, when an appropriation was made for the construction of a lighthouse at Cape May. Following the construction of the Cape May Lighthouse, a series of lighthouses were constructed along the New Jersey shoreline, including the Barnegat Lighthouse Tower and the Little Egg Harbor Light.

Between 1848 and 1878, a total of at least 125 shipwrecks have been documented off the Atlantic coastline between Barnegat Inlet and Manasquan Inlet. A single historic vessel has been archaeologically recorded in the project area. In 1988, the remains of a boat were located at the intersection of the southbound lane of Route 35 with Fielder Avenue in Ortley Beach, about 250 yards west of the shore. The vessel was undated.

The first Federal appropriation for life saving stations in any state occurred in 1848 when $10,000 was set aside to provide for life boats, rockets and the construction of eight life saving stations on the New Jersey coast between Sandy Hook and Little Egg Harbor. The observation towers, small wooden buildings and tiny boats associated with these posts were the only means of defense against the loss of human lives. Initially, there were two life saving stations on Long Beach Island. The first was located at Harvey Cedars and the second near Bond's Hotel. In 1870, Congress provided the first funds for a professional United States Life Saving Service and in 1886, the Federal government inaugurated the policy of manning all stations with paid crews. Lovelady's Island, Harvey Cedars and Long Beach Life Saving Stations still stand today in their original locations. The 1898 U.S. Life-Saving Station #14 at Island Beach State Park is listed on the National Register of Historic Places and the Point Pleasant Beach Coast Guard Station is considered eligible for listing.

3.3.5 Socioeconomic Environment

Oyster Creek is located in the township of Lacey. It was founded in 1871. This township is bordered on the east by Barnegat Bay, north by Berkeley Township, south by Ocean Township and on the west by pinelands. The land area consists of 84.6 square miles. Lacey had a population of 25,346 in 2000. This was a 14.5 percent increase from the 1990 census when the population was 22,141.

3.3.6 Aesthetic and Visual Resources

The Oyster Creek site contains a variety of flora and fauna that can be enjoyable to observe; the dominant tall phragmites, however, blocks views in most areas of the site. Conversations with several local residents during the environmental testing field studies indicated that they consider the phragmites an eyesore, and would prefer a better viewshed. The views of Oyster Creek and Barnegat Bay from parts of the southeastern areas of the site are aesthetically pleasing.

3.4 BARNEGAT LIGHTHOUSE

3.4.1 Physical Setting

The Barnegat Lighthouse site is located in Long Beach Township, in the Municipality of Barnegat Light. It is on the southern side of Barnegat Inlet, immediately southeast of Barnegat Lighthouse; it is part of Barnegat Lighthouse State Park. The site is bordered on two sides by open water, to the north by the Barnegat Inlet, and to the east by the Atlantic Ocean (see Figure 3-5). The site comprises a total of 117 acres, including open water. Many physical changes have occurred in the immediate vicinity of the site since the construction of the south jetty was completed 10 years ago. Dredged sand was spread over parts of the site as part of the south jetty project; there has also been natural accretion of sand. A large freshwater pond that previously existed near the northwestern part of the site was filled in; a semi-wet area dominated by phragmites now exists in its place (in part). The dune system has been gradually accreting in the southern and eastern parts of the site.

3.4.1.1 Physiography and Topography

Barnegat Bay watershed topography varies from rolling to flat. The Atlantic Coastal Plain rises from sea level along the coast to an altitude of about 200 feet in the northwest corner of Ocean County (USACE 2001).

The terrain in the immediate vicinity of the site is primarily flat to slightly rolling in the southwest on the existing dunes. According to recent preliminary topographic surveys performed in early 2002 at the Barnegat Lighthouse site by USACE, vertical elevations vary from about 1.5 feet NAVD in a low area in the northern part of the existing phragmites to about 10 feet at the highest part of the dunes in the southwestern part of the site (AMA 2002).

3.4.1.2 Climate

The climate in Ocean County, New Jersey is continental in nature. Winter temperatures average about 33º Fahrenheit (F), with an average countywide minimum temperature of 24ºF. The average summer temperature is about 72ºF, with an average daily maximum temperature of 83ºF. Precipitation in the county is well distributed throughout the year; the growing season extends from April through September. About 52 percent of the average annual precipitation, equaling approximately 24 inches, falls during the growing season (USACE 2001).

3.4.1.3 Infrastructure

The Barnegat Lighthouse site is undeveloped and contains no paved roads, buildings, power

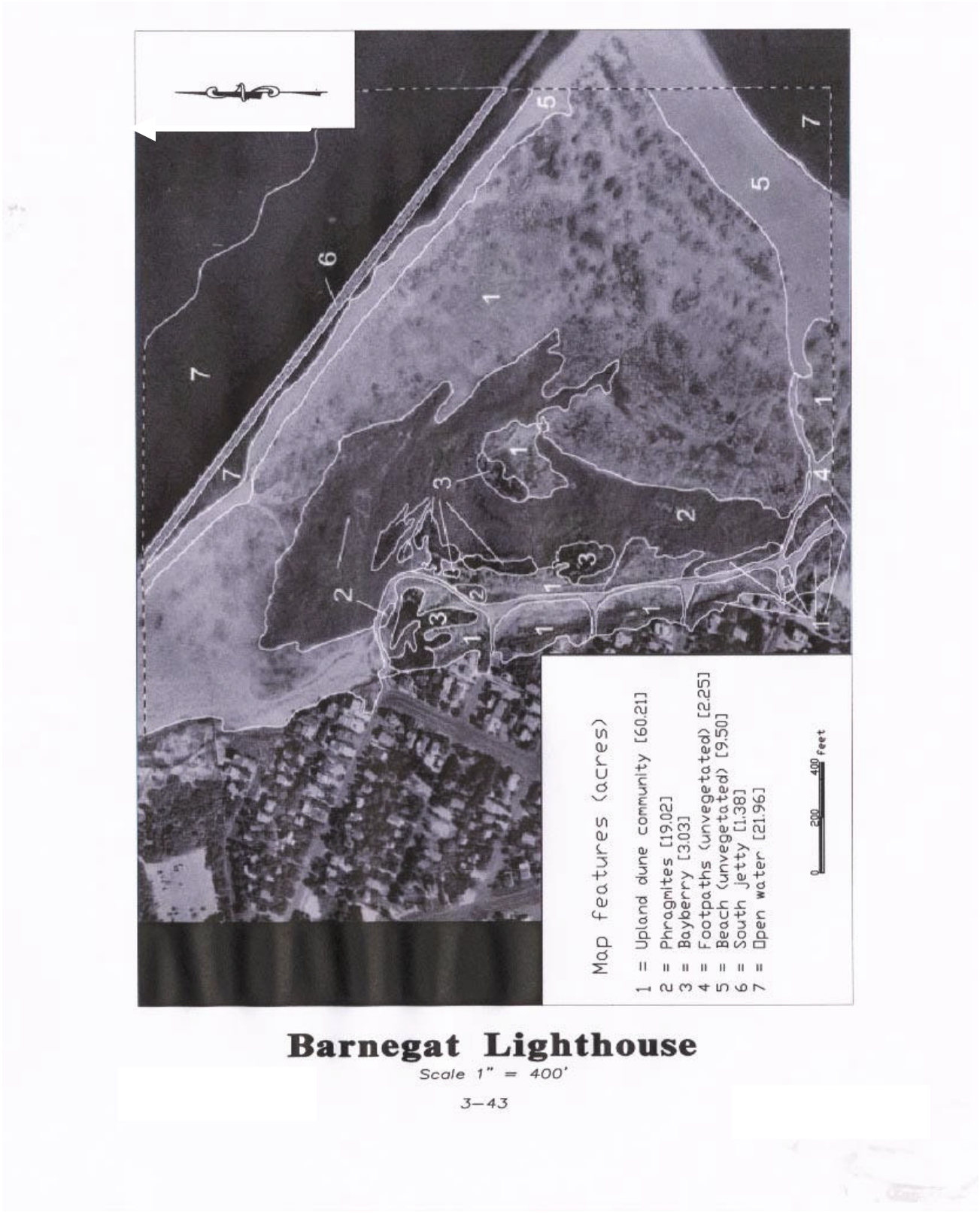


Figure 3-5 Barnegat Lighthouse (Scale 1” – 400’)

facilities, rights-of-way, or other anthropogenic infrastructure. The site, however, is directly adjacent to the historic Barnegat Lighthouse, and its parking area and facilities. The site is also directly bounded by several Barnegat Light cross streets and many residences. Many footpaths are currently present at the site, used by pedestrians and beach vehicles to access the beach.

3.4.2 Environmental Setting

3.4.2.1 Land Use, Ownership, Management Plans

The Barnegat Lighthouse site is owned by NJDEP; it is part of Barnegat Lighthouse State Park. A small area within the northeastern dunes adjacent to the beach is currently managed by the NJDEP Division of Fish and Wildlife for breeding piping plovers, a Federal listed Threatened and state listed Endangered species, and breeding least terns, a state-listed Endangered species (refer to the subsequent Other Wildlife section).

3.4.2.2 Fisheries

Owing to the nature of the project (i.e., creation of new habitat for piping plover), little information pertaining to fisheries was gathered at the Barnegat Lighthouse site, because it was deemed to be irrelevant.

The Barnegat Lighthouse site is adjacent to a large geographic area of Barnegat Bay mapped as EFH; no EFH is mapped as part of the site. In its guide to EFH designations in the northeastern United States, NMFS provides a comprehensive summary of EFH designations completed by the New England Fishery Management Council, the Mid-Atlantic Fishery Management Council, the South Atlantic Fishery Management Council, and the NMFS, pursuant to the Magnuson-Stevens Fishery Conservation and Management Act (Act). The 1996 amendments to the Act strengthened the ability of NMFS to protect and conserve the habitat of marine, estuarine, and anadromous finfish, mollusks, and crustaceans. This habitat is broadly defined to include "those waters and substrate necessary to fish for spawning, breeding, feeding, or growth to maturity" (NMFS 1999). Under the Act, the NMFS must coordinate with other Federal agencies that could adversely affect EFH. In turn, NMFS must provide recommendations to Federal and State agencies on such activities to conserve EFH. These recommendations may include measures to avoid, minimize, mitigate, or otherwise offset adverse effects on EFH (NMFS 1999).

3.4.2.3 Benthic Community

There were no benthic invertebrate samples specifically taken at any of the six sites considered under this project. There are data, however, on benthic communities present in the southern part of the Barnegat study area that may be comparable to the communities in other tidal sites. These data were obtained as part of the feasibility study for dredged holes restoration in Barnegat Bay (Scott and Kelley 1999; USACE 2001). The benthic communities at the dredged hole sites are in the same geographic region and in similar estuarine habitats as those being considered under this feasibility study. In general, arthropods, specifically amphipods (small shrimp type crustaceans) and polychaete worms dominated the benthic community. This was true in both seasons, as well

as at the different depths. The numerically dominant amphipods were in the genus *Ampelisca* spp., while the numerically dominant polychaetes were in the Capitellidae family (i.e., *Mediomastus ambiseta* and *Capitella capitata*). In addition, the majority of the epifaunal species collected from the area were amphipods.

3.4.2.4 Other Wildlife

Wildlife and their signs (tracks, scats, calls, and other identifiable physical evidence) observed at and near the Barnegat Lighthouse site while conducting the field studies and the agency site meetings were primarily all birds. Several small dead sharks and fish were noted along the flooded area behind the south jetty; numerous individuals of one identified benthic worm species were also observed in this area during one field visit. Birds observed over several visits to the site included piping plover (*Charadrius melodius*), semipalmated plover (*Charadrius semipalmatus*), sanderling (*Calidris alba*), least sandpiper (*Calidris minutilla*), spotted sandpiper (*Actitus macularia*), laughing gull (*Larus atricilla*), greater black-backed gull (*Larus marinus*), herring gull (*Larus argentatus*), common tern (*Sterna hirundo*), Forster's tern (*Sterna fosteri*), and osprey (*Pandion haliaetus*). Most of the birds were observed flying or feeding near the open water along the south jetty and the beach in the southern part of the site. Two adult piping plovers were observed in the southern part of the site in the dune area near the beach. The piping plovers observed had recently fledged young several weeks before, and were likely temporarily remaining at the site (personal communication, D. Jenkins, NJDEP). It should be noted that a large part of the southern area of the site is fenced off from the public and is posted as piping plover breeding habitat. NJDEP erects and takes down the semi-permanent fence every year (i.e., the fence is taken down after the conclusion of the piping plover breeding season) through a local volunteer effort.

3.4.2.5 Vegetation and Land Cover

Existing vegetation and land cover were mapped at the Barnegat sites during the environmental testing studies conducted for the project (Harriott and Southerland 2001); this information is subsequently presented on figures in Chapter 5 of this report. The primary vegetation type at the Barnegat Lighthouse site consists of an upland herbaceous dune community. The principal species in the dune community include American beachgrass (*Ammophila breviligulata*), white sweet clover (*Melilotus alba*), seaside goldenrod (*Solidago sempervirens*), sandbur (*Cenchrus tribuloides*), and beach heather (*Hudsonia ericoides*). Phragmites, primarily on uplands, comprises the second largest vegetation type on the site; it exists primarily in a broad north-south band in the western part of the site (Figure 3-5, areas 2). The phragmites in the parcel is nearly monotypic, but appears relatively weak (it is generally not tall and robust). A small area of the phragmites near the northern part of the parcel (on the jetty side) is likely in wetlands, but this area was not mapped separately from area 2. The only other vegetated areas are small, scattered parcels of bayberry (*Myrica pensylvanica*), primarily in the western part of the site. Vegetation in these parcels is dominated by dense bayberry thickets, but some of the other species from the dune community are also occasionally present.

3.4.2.6 Threatened and Endangered Species

The New Jersey Natural Heritage database indicates that records exist for piping plover (*Charadrius melodus*) and least tern (*Sterna antillarum*) in the vicinity of the Barnegat Lighthouse site. All of the location information for both species indicates a much larger area than that of the Barnegat Lighthouse site. The single record for piping plover is from June, 1996. The three records for least tern are from summer of 1996, summer of 1986, and 1983 (no season given). Piping plovers are listed as Federal Threatened and state Endangered. They are considered to be somewhat rare throughout their natural range, and their breeding populations are considered critically imperiled in New Jersey. Least terns are state listed as Endangered; they are apparently secure throughout their natural range, but breeding populations are considered critically imperiled in New Jersey. Heritage records for both of these species at this site are not surprising; piping plover was observed at the site during the field studies, and has been intensively studied. Least terns are also regularly observed at the site (personal communication, David Jenkins, NJDEP). The proposed restoration project at the Barnegat Lighthouse site is expected to have a significant positive effect on the breeding population of piping plovers at the site. Because they utilize similar (but not identical) habitats, the proposed restoration may also have a significant positive effect on least tern.

NJDEP has made several attempts at improving conditions for piping plover at the site by clearing vegetation in small areas between dunes by disking with a small tractor and disk attachment. Although the attempts have been partially successful (several pairs of piping plovers nest at the site), it was concluded that restoration efforts could be much more successful if an area of shallow, open intertidal water feeding habitat directly adjacent to nesting habitat was provided.

3.4.2.7 Wetlands

As mapped in the Barnegat Bay Ecosystem Restoration Environmental Testing and Restoration Proposals report (Harriott and Southerland 2001), wetlands on the Barnegat Lighthouse site include portions of the 19.02 acres of phragmites and all of the 21.96 acres of open water. It is estimated that roughly 5 acres of the northern-most portion of the phragmites possesses hydrology sufficient to delineate it as wetlands (this area is on wet sand substrate). Other non-wetland areas of the phragmites parcel are on very dry sand and exhibit very small, weak individual plants.

3.4.2.8 Air Quality

There are several air monitoring stations in southeastern New Jersey. The Edwin B. Forsythe National Wildlife Refuge, extending along the Ocean County coast, monitors ambient ozone and sulfur dioxide concentration. Carbon monoxide, total particulates, and lead are monitored at an Atlantic City, New Jersey station; another station in Millville, New Jersey monitors nitrogen oxides (USACE 2001).

USEPA has reported that ozone levels within Ocean County persistently exceed national air quality standards, causing the county to be classified as a non-attainment area for ozone. All other pollutants listed by USEPA are currently in attainment status (USACE 2001).

3.4.2.9 Hazardous, Toxic & Radioactive Waste

In accordance with ER 1165-2-132, entitled *Hazardous, Toxic and Radioactive Wastes (HTRW) Guidance for Civil Works Projects*, dated 26 June 1992, investigations must be conducted to assess the existence, nature and extent of HTRW within a project impact area (Comprehensive Environmental Response, Compensation, and Liability Act [CERCLA], 42 U.S.C. > 9601 et seq., as amended). Hazardous substances regulated under CERCLA include "hazardous wastes" under Section 3001 of the Resource Conservation and Recovery Act (RCRA), (42 U.S.C. 6921 et seq.), "hazardous substances" identified under Section 311 of the Clean Water Act (33 U.S.C. 1317); "hazardous air pollutants" designated under Section 112 of the Clean Air Act (42 U.S.C. 7412); and "imminently hazardous chemical substances or mixtures," upon which USEPA has taken action under Section 7 of the Toxic Substance Control Act (15 U.S.C. 2606).

To comply with the HTRW sections as mandated under CERCLA, Environmental Data Resources (EDR) was retained to conduct assessments of the potential presence of hazardous, toxic, or radioactive waste at the six Barnegat sites. Several sources of data were consulted to complete the HTRW evaluation and to determine the potential for encountering on-site hazards. Each assessment by EDR included searches of Federal and state data bases; CERCLIS and NPL data bases; RCRA data bases; the ERNS data base; the CORRACTS data base; the SPL data base; permitted solid waste disposal; state UST and LUST sites; as well as other data sources.

Existing data base information (as well as site observations during the ecological field studies) suggests little potential for encountering hazards on the Barnegat Lighthouse site. The EDR report also indicates that there are no potential hazards on any directly adjacent properties. Several records of minor, primarily residential-related spills were mapped by EDR within one-quarter mile of the site. These mapped "contaminated" sites are not likely to have any negative effect on the proposed restoration.

3.4.2.10 Water Resources

Surface water quality was not measured at the Barnegat Lighthouse site during the field visits, as it was deemed not to be necessary for design and planning of the restoration.

The Barnegat Lighthouse site is surrounded by surface water on two sides; to the north is Barnegat Inlet and to the east is the Atlantic Ocean. This site sees seasonally heavy public use, as there are many footpaths present between the public access points on 5th, 6th, and 7th streets and the beach along the southern boundary. Swimming on the Atlantic Ocean side and fishing on the inlet side are seasonally common practices. A small amount of fresh water also drains from the existing phragmites to the linear ponded area behind the south jetty.

3.4.2.11 Geology and Soil

No information was collected on the existing geology or soils of the site during the environmental testing field studies. It is clear, however, from many visits to the site that the soils are composed entirely of fine to medium sands.

3.4.3 Recreational Facilities

The Barnegat Lighthouse site is highly public; it is not only within state park lands, but is also directly adjacent to a densely developed area. Footpaths exist from the main beach access points to a main footpath along the western edge of the site. Additional footpaths branch off of the main path and meander through the site (particularly in the southwestern part). These footpaths are heavily traveled in-season by beach-users.

3.4.4 Cultural Resources

In preparing the draft Feasibility Study, USACE has consulted with the NJ SHPO and other interested parties in order to assess the potential for historic properties in the project area as required under Section 106 of the National Historic Preservation Act of 1966, as amended, and its implementing regulations, 36 CFR Part 800. Section 106 consultation with the NJ SHPO is continuing and will be concluded prior to any project construction activity. The following brief summary outlines several cultural resources investigations conducted by USACE in the Barnegat Bay area and provides a very general history of the region.

USACE has conducted several cultural resources investigations in the Barnegat Bay region in preparation for possible construction of flood control measures in the Manasquan River Basin, proposed ocean shoreline protection projects along the barrier islands between Manasquan Inlet and Long Beach Island, and maintenance activities associated with the operation of Barnegat Bay Inlet. USACE conducted a Phase 1A cultural resources investigation in 1978 in preparation for inlet dredging, shoreline sand placement and new jetty construction at Barnegat Inlet (Gilbert/Commonwealth, 1979). Researchers identified 13 historic properties in the project area vicinity utilizing records background research and on site field reconnaissance. No prehistoric sites were identified.

USACE has completed four cultural resources studies in the northern Barnegat Bay area. The first study, entitled A Phase 1A Cultural Resources Investigation of the Manasquan River Basin, Monmouth and Ocean Counties, New Jersey (Hunter Research Inc. 1993), generated a cultural resource database for the Manasquan River watershed as a planning tool in the development of flood control improvements in the 80 square mile basin. The second investigation entitled Phase 1A Cultural Resources Investigations, Manasquan Inlet to Barnegat Inlet, Ocean County, New Jersey (Hunter Research Inc. 1997) compiled existing cultural resource information from archival and historic map sources to identify known and expected historic properties in that coastal area. In addition, a low-tide pedestrian archeological survey was conducted along the shoreline in the northern portion of the project area from Manasquan Inlet to the northern boundary of Island Beach State Park. One possible shipwreck site was identified in the near-shore surf zone.

In the third study, entitled Phase I Submerged and Shoreline Cultural Resources Investigations, Manasquan Inlet to Barnegat Inlet, Ocean County, New Jersey (Dolan Research, Inc. 2001), researchers investigated proposed project offshore borrow areas, submerged near-shore locations, and terrestrial shoreline areas utilizing magnetometer, side-scan, and bathymetric data collection techniques. Nineteen remote sensing targets exhibiting shipwreck characteristics were identified in the submerged portion of the near-shore area. In the fourth study, entitled Supplemental Phase I Submerged Cultural Resources Investigations, Borrow Area "B", Manasquan Inlet to Barnegat Inlet, Ocean County, New Jersey (Dolan Research, Inc., 2001), researchers conducted remote sensing in an expanded portion of offshore Borrow Area B. No significant cultural resources were identified.

USACE completed two cultural resources investigations in the southern Barnegat Bay area in association with proposed ocean shoreline protection activities on Long Beach Island. The first study, entitled Phase I Submerged and Shoreline Cultural Resources Investigations and Hydrographic Survey, Long Beach Island, Ocean County, New Jersey (Hunter Research, Inc., Dolan Research Inc. and Enviroscan, Inc., 1998) discusses the results of near-shore tidal and offshore borrow area investigations. Eleven underwater targets exhibiting shipwreck characteristics were identified. In a follow-up investigation entitled Supplemental Phase IB and Phase II Cultural Resources Investigations, New Jersey Atlantic Coast, Long Beach Island, Ocean County, New Jersey (Dolan Research, Inc., 2001), researchers discuss the investigation of the eleven targets identified in the previous study. Two of the targets were found to be shipwrecks that appear to meet the minimum eligibility requirements for listing on the National Register of Historic Places. The following historical summary is taken directly from the above referenced reports.

The majority of documented prehistoric sites in the Barnegat Bay vicinity are from the Woodland Period and are concentrated around the tidal estuaries of the Barnegat Bay and Manasquan Rivers. Notable features of the archaeology of this area are shell-middens and Native American burials. However, no burials are recorded from the Atlantic shoreline itself. Three prehistoric sites have been documented in Point Pleasant Beach and Ortley Beach, Dover Township. The recent discovery of a Paleo-Indian fluted point in Island Beach State Park is a significant find from this early period along the New Jersey shore. Despite a statewide survey of archaeological resources conducted in the early part of this century and more recent cultural resources investigations, no confirmed prehistoric sites have been identified within the tidal zones of the Bay or ocean shorelines on Long Beach Island itself.

The increasing population of the area in the third quarter of the 19th century led to the establishment of a number of incorporated communities from 1886 onward. These include Bay Head Borough (1886), Harvey Cedars (1894), Island Beach Borough (1933-1965), Lavallette Borough (1887), Mantoloking Borough (1911), Point Pleasant Beach Borough (1886), Seaside Heights Borough (1913) and Seaside Park Borough (1898).

A review of the historic map coverage of the project area documents the development of the shore from a barely-inhabited barrier island to a fully-developed resort community. At the time of the 1776 Holland Map no settlements or isolated dwellings were shown on the barrier islands.

The mainland area is described as “Sandy Barren Deserts”, and only one road reached the coast in the project area, opposite Barnegat Inlet. A second inlet, identified as “New Inlet” lay north of Barnegat Inlet in the area of the present Toms River. By 1850, eight individual structures, five of them with owner's names attached, are shown on the island. The New Inlet of 1776 was subsequently renamed Cranberry Inlet but is marked as closed on the 1850 map. It had apparently filled in by about 1812.

The 1872 Beers map shows a minor increase in recreational use of the region. The development of Point Pleasant continues and three roads lead to the shoreline from the Manasquan River area. Numerous hotels and boarding houses shown include the Ocean Hotel and Cook property near the Manasquan River, Chadwick's Hotel in Chadwick, an unnamed hotel in the present Seaside Heights, and Reed's Hotel within the present limits of Island Beach State Park. Three life saving stations are also shown.

An 1878 map shows two planned seaside resort communities in the project area, Lavallette and Seaside Heights, and six life-saving stations, all numbered on the national system and given identifying names. By 1883, a railroad connection ran down the Island from the north as far down as Seaside Park, from where it crossed Barnegat Bay south of Toms River. Since the late 19th century much of the remainder of the coast has been developed. Island Beach State Park was set aside prior to World War II, during which time this area was used for missile development and testing. The park was formally opened in 1959.

Although Barnegat Bay was utilized by local anglers and sportsmen throughout the 19th and 20th centuries, the majority of commercial shipping occurred in the shipping lanes running adjacent to the island's Atlantic Ocean shoreline. Over the centuries numerous ships have been wrecked along New Jersey's 127-mile-long coast line and a great number occurred specifically off Long Beach Island. By the first quarter of the 19th century, volunteer life saving stations had been established in many locations along New Jersey's coast. The first Federal assistance came in 1823, when an appropriation was made for the construction of a lighthouse at Cape May. Following the construction of the Cape May Lighthouse, a series of lighthouses were constructed along the New Jersey shoreline, including the Barnegat Lighthouse Tower and the Little Egg Harbor Light.

Between 1848 and 1878, a total of at least 125 shipwrecks have been documented off the Atlantic coastline between Barnegat Inlet and Manasquan Inlet. A single historic vessel has been archaeologically recorded in the project area. In 1988, the remains of a boat were located at the intersection of the southbound lane of Route 35 with Fielder Avenue in Ortley Beach, about 250 yards west of the shore. The vessel was undated.

The first Federal appropriation for life saving stations in any state occurred in 1848 when $10,000 was set aside to provide for life boats, rockets and the construction of eight life saving stations on the New Jersey coast between Sandy Hook and Little Egg Harbor. The observation towers, small wooden buildings and tiny boats associated with these posts were the only means of defense against the loss of human lives. Initially, there were two life saving stations on Long Beach Island. The first was located at Harvey Cedars and the second near Bond's Hotel. In

1870, Congress provided the first funds for a professional United States Life Saving Service and in 1886, the Federal government inaugurated the policy of manning all stations with paid crews. Lovelady's Island, Harvey Cedars and Long Beach Life Saving Stations still stand today in their original locations. The 1898 U.S. Life-Saving Station #14 at Island Beach State Park is listed on the National Register of Historic Places and the Point Pleasant Beach Coast Guard Station is considered eligible for listing.

3.4.5 Socioeconomic Environment

Barnegat Light had a 13.2 percent increase in population from 675 in 1990 to 764 in 2000.

3.4.6 Aesthetic and Visual Resources

The beach area on the southern boundary is used frequently by the public for recreational and aesthetic purposes. In addition, the historic Barnegat Lighthouse is also likely visited by thousands of people every year. While the lighthouse is an aesthetic antiquity in itself, it is also possible to climb to the top of the lighthouse for scenic views of the entire area.

3.5 STAFFORD FORGE

3.5.1 Physical Setting

The Stafford Forge site is located in Eagleswood and Little Egg Harbor Townships, about two miles north of the town of West Creek, on Westecunk Creek, to the immediate north of the Garden State Parkway. The site is a former cranberry bog, now managed for wildlife by NJDEP. The site as mapped comprises a total of about 527 acres (see Figure 3-6). According to NJDEP, the site was used as a cranberry bog operation as recently as the early-to-mid 1960s (personal communication, D. Wilkinson, NJDEP). The site consists of a series of five very large ponds (numbered in this study 1 to 5, from north to south); two ponds (1 and 5) are directly on-line with Westecunk Creek, and three are off-line (2, 3, and 4). Westecunk Creek flows onto the site at the northern-most part of Pond 1 and south through the eastern side of the site; Governors Branch flows onto the site at the southwestern corner of Pond 1.

3.5.1.1 Physiography and Topography

Barnegat Bay watershed topography varies from rolling to flat. The Atlantic Coastal Plain rises from sea level along the coast to an altitude of about 200 feet in the northwest corner of Ocean County (USACE 2001).

The terrain in the immediate vicinity of the site is relatively flat to gently rolling. The on-site ponds were likely originally excavated (where necessary) and then graded flat to make them suitable for use as cranberry bogs. The existing sandy berms were likely constructed with sandy materials from the original pond excavations. Field observations of Pond 1 and Pond 2 in a semi-drained state during the summer of 2001 indicate these areas are very flat. According to preliminary surveys performed in early 2002 at the Stafford Forge site by Andrews, Miller &

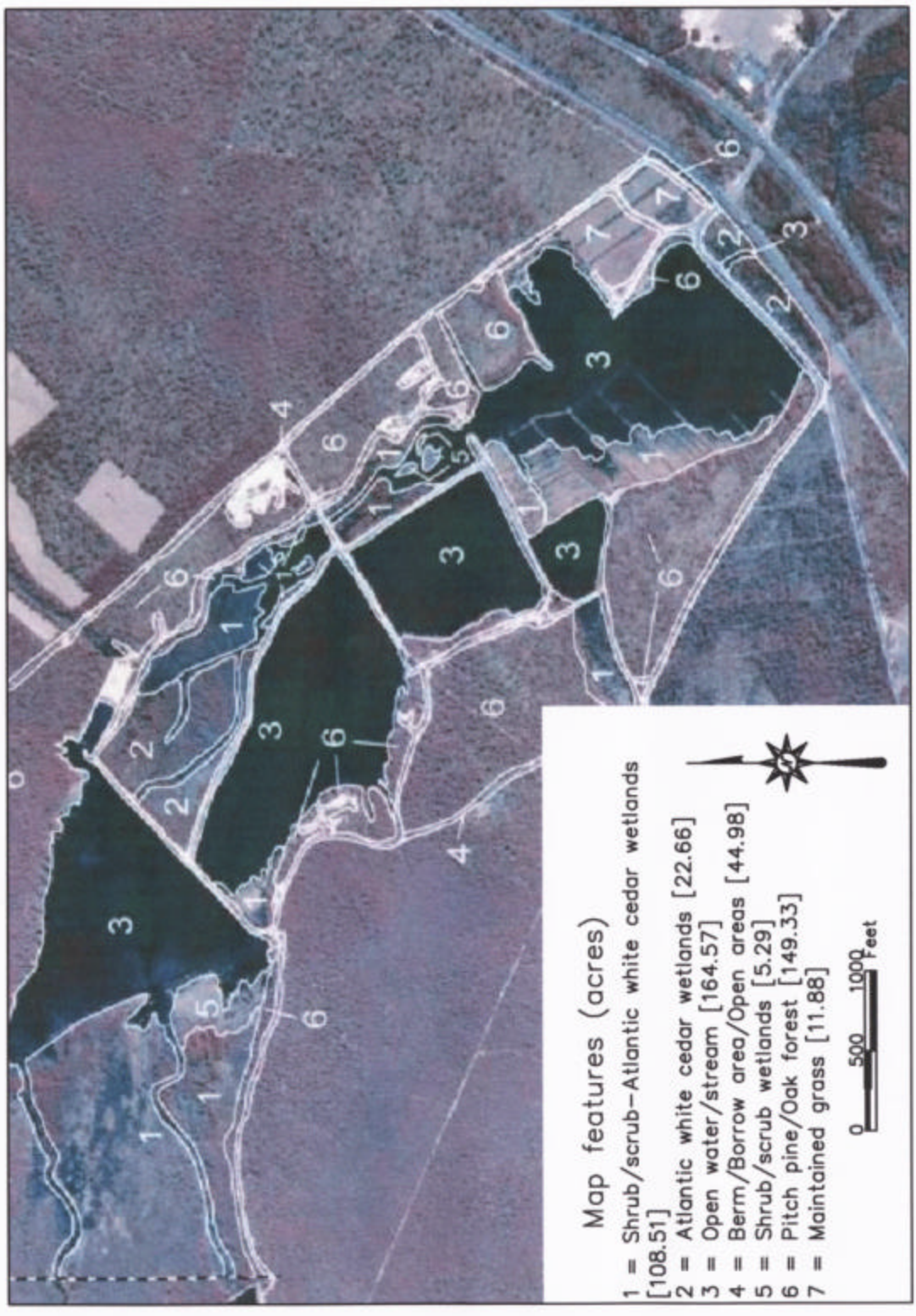


Figure 3-6 Stafford Forge (Scale 1" – 1,000')

Associates, vertical elevations on the ponds vary from about 16.5 feet North American Vertical Datum of 1988 (NAVD) near the downstream water control structure on Pond 5, to about 26.9 feet NAVD in the water near the center part of the berm on Pond 1. The highest elevation measured on the berms was about 33.7 feet NAVD near the middle of the berm adjacent to Pond 1 (AMA 2002).

3.5.1.2 Climate

The climate in Ocean County, New Jersey is continental in nature. Winter temperatures average about 33º Fahrenheit (F), with an average countywide minimum temperature of 24ºF. The average summer temperature is about 72ºF, with an average daily maximum temperature of 83ºF. Precipitation in the county is well distributed throughout the year; the growing season extends from April through September. About 52 percent of the average annual precipitation, equaling approximately 24 inches falls during the growing season (USACE 2001).

3.5.1.3 Infrastructure

The Stafford Forge site is undeveloped and contains no paved roads, buildings, power facilities, rights-of-way, or other anthropogenic infrastructure. A system of water control structures, berms, and dirt roads were created for use of the site as a cranberry bog as early as the 1930s. Since the site was abandoned for cranberry production in the 1960s, it is only intermittently used for recreation by hunters and anglers, and is only irregularly maintained by the NJDEP.

Pond 1 impounds water over a 44-acre area at relatively shallow depths behind its 2,000-foot long embankment. The pond releases its water primarily to the main stream of Westecunk Creek through a water control structure located approximately midway through the berm. This structure consists of four 30-inch diameter CMP (corrugated metal pipe) culverts, with a 24-inch diameter semicircular CMP riser at the inlet of each pipe with slots for controlling intake water levels with stoplogs.

Another existing structure, located further downstream along the Westecunk Creek, consists of triple 54-inch diameter CMP culverts with semicircular CMP riser with slots for stoplogs. Except for a beaver dam that was discovered in the Summer of 2001 immediately downstream of this structure, the stream flows freely from this point through Pond 5 and down to the water control weir structure at Stafford Forge Road. Due to its dilapidated condition and based on dam safety considerations, this major water control structure is currently under renovation by NJDEP, with the intent being primarily "in-kind" replacement of the deteriorating components of the structure. Consequently, it is stipulated that the basic function and the hydraulic characteristics of the structure will remain unchanged as a result of this renovation.

Another structure with twin 30-inch diameter riser-pipe culverts is located at the southernmost end of the berm which defines the downstream boundary of Pond 1. This structure releases water from Pond 1 to Pond 2. CMP culverts were also found at several other locations along the berm of Pond 1. However, these culverts are largely dilapidated structurally, their inlets and barrels are clogged and/or locally crushed, and as such, they are considered non-functional as water control structures or even as uncontrolled outlet structures.

A series of culvert pipes convey water across the berms from Pond 2 to Pond 3, then to Pond 4, and to Pond 5. The overall dimensions of these pipes (18" to 30" in diameter) and berms (4 to 6 ft high) as well as the ground elevations over the predominantly flat impoundment areas behind the berms separating the ponds indicate that each of these ponds can accumulate water 4 to 6 feet in depth during wet periods. As also revealed by field observations, however, the water depths in these ponds can be very shallow during drier periods.

In addition to the field observations made during several site visits, AMA performed field surveys and Mr. Curtis Orvis of USFWS conducted field measurements to obtain data on the various existing water control structures in the project area. This data included information on the water control structure at Stafford Forge Road at the downstream end of Pond 5, site-specific data on the triple 54-inch riser-pipe culverts upstream of the beaver dam along Westecunk Creek, and information on the quad 30-inch and twin 30-inch riser-pipe culverts along the berm of Pond 1. Data were also collected on the pipes, berms and typical ground elevations throughout Ponds 2, 3 and 4. The results of the field data collection are presented in the Engineering Technical Appendix E – Section 3: Surveying and Mapping Requirements.

The surveys at the water control structure at Stafford Forge Road generally verified the dimensions and topographic data shown on the plans prepared for the refurbishment of this structure by Lippincott & Jacobs (L&J). These plans were obtained through coordination with NJDEP, and represent reference drawings for the existing structure.

3.5.2 Environmental Setting

3.5.2.1 Land Use, Ownership, Management Plans

The Stafford Forge site is owned by NJDEP, Division of Fish and Wildlife. The Stafford Forge site is surrounded by very large areas of dry, upland pine-oak forest in the Wildlife Management Area (WMA) that has been managed by NJDEP for wildlife and hunting. Water levels have apparently been manipulated in the past on the 5 site ponds by NJDEP, but the degraded water-control structures, culverts, and pipes now make such changes difficult (in some cases, impossible). Many of the structures and pipes are partially functional or non-functional; most of them are partially blocked with sticks and debris. The main water control structure at the southern end of Pond 5 on Stafford Forge Road is dilapidated and needs to be replaced. NJDEP currently has developed engineering plans for replacement of this main water control structure; it is not yet certain when the new structure will be constructed.

During several meetings and discussions between USACE and NJDEP Division of Fish and Wildlife concerning the Stafford Forge site, NJDEP indicated they were willing to partner on restoration at the site as part of their upgrades to the water control structures. Specific elements discussed included installation of one or more fish ladders on Westecunk Creek for migration of anadromous fish (alewife) and partial or full draining of Ponds 2, 3, and 4 for establishment of emergent wetlands. These elements are discussed individually in the sections below.

3.5.2.2 Fisheries

Historical data shows that anadromous fish such as alewife have used this creek, but are limited in migration by water control structures. Based on recent mapping measurements of the Westecunk Creek system, there are a combined total of approximately 10.2 miles of stream above the Stafford Forge site. Presumably a large percentage of this potential fishery habitat would be made available with implementation of fish passage at Stafford Forge. NJDEP has indicated that the fishery is generally very poor throughout all of the ponds at the Stafford Forge site (personal communication, H. Carberry, NJDEP). This was further indicated by the fact that anglers were never observed fishing the ponds during any of the field visits to the site.

3.5.2.3 Benthic Community

There were no benthic invertebrate samples specifically taken at any of the six sites considered under this project. There are data, however, on benthic communities present in the southern part of the Barnegat study area that may be comparable to the communities in other tidal sites. These data were obtained as part of the feasibility study for dredged holes restoration in Barnegat Bay (Scott and Kelley 1999; USACE 2001). The benthic communities at the dredged hole sites are in the same geographic region and in similar estuarine habitats as those being considered under this feasibility study. In general, arthropods, specifically amphipods (small shrimp type crustaceans) and polychaete worms dominated the benthic community. This was true in both seasons, as well as at the different depths. The numerically dominant amphipods were in the genus *Ampelisca* spp., while the numerically dominant polychaetes were in the Capitellidae family (i.e., *Mediomastus ambiseta* and *Capitella capitata*). In addition, the majority of the epifaunal species collected from the area were amphipods.

3.5.2.4 Other Wildlife

Wildlife and their signs (tracks, scats, calls, and other identifiable physical evidence) were observed at and near the Stafford Forge site while conducting the field studies. These included great egret (*Casmerodius albus*), snowy egret (*Egretta thula*), great blue heron (*Ardea herodias*), mute swan (*Cygnus olor*), mallard duck (*Anas platyrhynchos*), black duck (*Anas rubripes*), brown thrasher (*Toxostoma rufum*), prairie warbler (*Dendroica discolor*), pine warbler (*Dendroica pinus*), white-eyed vireo (*Vireo griseus*), rufous-sided towhee (*Pipilo erythropthalmus*), house wren (*Troglodytes aedon*), painted turtle (*Chrysemys picta picta*), and mud turtle (*Kinosternon subrubrum subrubrum*). In addition, evidence of beaver (*Castor canadensis*), and white-tailed deer (*Odocoileus virginianus*) was abundant throughout the site and the upper watershed.

The great egrets, snowy egrets, and great blue herons were observed in Pond 1. Several mute swans were observed on Pond 1 during several winter 1999 visits to the site. Black ducks and mallard ducks were observed in Pond 1 and Pond 5; mallard ducks were also observed in other locations in the upper Westecunk Creek watershed. Pine warblers, prairie warblers, white-eyed vireos, and rufous-sided towhees were heard and observed in the recently burned pine/oak forest along the west-central section of the site. One brown thrasher was observed along an access road adjacent to Governors Branch. Several house wrens were heard and observed in the open,

maintained grassy area in the southeastern corner of the site. Several painted turtles were observed basking near the southwestern corner of Pond 1. One mud turtle was observed in the shrub/scrub wetland immediately east of Pond 4. A moderately-sized active beaver dam exists on Westecunk Creek immediately downstream of the middle berm. Two apparently current beaver lodges also were observed on the east side of Pond 4; beaver-related damage was also apparent on several adjacent trees (no direct sightings were made, however). Evidence of white-tailed deer was abundant throughout the site, although no direct sightings were made during the field studies.

It should be noted that, despite the presence of a large quantity of open fresh water at the site, surprisingly few ducks, waterfowl, and aquatic birds in general were observed at the Stafford Forge site during at least 10 visits to the site in the fall, winter, spring, and summer months. The NJDEP Division of Fish and Wildlife has confirmed that the ponds are generally little-used, with the occasional exception of Pond 1 and Pond 5; these are intermittently used by dabbling ducks such as blue-winged teal (*Anas discors*), and American wigeons (*Anas americana*) (personal communication, W. Tonneson, NJDEP). In addition, NJDEP has indicated that the fishery is generally very poor throughout all of the ponds at the Stafford Forge site (personal communication, H. Carberry, NJDEP). This was further indicated by the fact that anglers were never observed fishing the ponds during any of the field visits to the site.

3.5.2.5 Vegetation and Land Cover

Existing vegetation and land cover were mapped at the Barnegat sites during the environmental testing studies conducted for the project (Harriott and Southerland 2001); this information is subsequently presented on figures in Chapter 5 of this report. The primary vegetation type at the Stafford Forge site is upland pine-oak forest (Figure 3-6, areas 6). The dry forest is dominated by pitch pine (*Pinus rigida*) and several oak species, including scrub oak (*Quercus ilicifolia*), blackjack oak (*Quercus marilandica*), black oak (*Quercus velutina*), and white oak (*Quercus alba*). The forest possesses a dense shrub layer of lowbush blueberry (*Vaccinium angustifolium*) and huckleberry (*Gaylussacia baccata*). The herbaceous layer in the forest was very sparse to nonexistent; bracken (*Pteridium aquilinum*) is the only common herbaceous plant. Large areas of the forest on the west side of the site burned in a fire several years ago, and appear to be still re-generating.

The second-largest vegetation type at the Stafford Forge site is a shrub/scrub-Atlantic white cedar wetland association that dominates the majority of the northwestern part of the site and several smaller parcels along Westecunk Creek in the eastern part of the site (areas 1). The shrub-scrub is dominated in most areas of the site by a mixture of ericaceous shrubs such as maleberry (*Lyonia ligustrina*), dwarf huckleberry (*Gaylussacia dumosa*), highbush blueberry (*Vaccinium corymbosum*), and large cranberry (*Vaccinium macrocarpon*), as well as other species such as speckled alder (*Alnus rugosa*) and sweet pepperbush (*Clethra alnifolia*). Many of the shrub-dominated areas of the shrub-scrub also possess an herbaceous understory of wooly sedge (*Carex lanuginosa*) and several other sedges. Other areas of the shrub-scrub are dominated by small Atlantic white cedar (*Chamaecyparis thyoides*) and red maple (*Acer rubrum*) trees with little understory. The areas possessing trees are scattered throughout the shrub-scrub.

Also present at the Stafford Forge site are two variations of the shrub/scrub-Atlantic white cedar wetlands; these include Atlantic white cedar wetlands and shrub/scrub wetlands. The principal species in these variations are essentially the same as those in the principal type (see above), but vary in dominance. The Atlantic white cedar wetlands (areas 2) are clearly dominated by dense stands of Atlantic white cedar, and possess very sparse shrub and herbaceous understories. In contrast, the shrub/scrub wetlands (areas 5) are composed of dense areas of shrubs with almost no cedars, interspersed with patchy, herb-dominated areas.

One large area of maintained grass exists in the southeastern corner of the Stafford Forge site (area 7). This area consists of planted, mowed grasses with linear rows of planted autumn olive shrubs (*Eleagnus umbellata*), and is all upland. It was presumably created as wildlife habitat for rabbits and white-tailed deer.

Other areas of the site also possess large areas of unvegetated open water in the creek corridor and open ponds (areas 3). A substantial number of man-made berms and dirt roads are also found throughout the site (areas 4). Many of the berms are very substantial, and are 9 to 10 feet tall. Several old borrow areas also exist along the dirt roads, where material was excavated for construction of the many berms and roads at the site.

3.5.2.6 Threatened and Endangered Species

The New Jersey Natural Heritage database indicates that recent records exist for one plant, Knieskern's beaked rush (*Rhynchospera knieskernii*) on the site. In addition, the records indicated two animals, pine barrens tree frog (*Hyla andersonii*), and Cooper's hawk (*Accipiter cooperii*), are also present at the site. According to these records, Knieskern's beaked rush was observed in 1994 adjacent to the northern-most pond; this species is listed as Federal Threatened and state Endangered, and is extremely rare throughout its entire naturally occurring range. Pine barrens tree frog was apparently recorded in several locations within Stafford Forge in 1990; this species is listed as state Endangered, but is apparently secure throughout other parts of its naturally occurring range. One pair of nesting Cooper's hawks were recorded in 1995 within Stafford Forge, along Old Forge Road to the north of the northern-most bog; this species is listed as state Threatened, but is secure within other parts of its naturally occurring range. No additional data is currently available on the status of these species at Stafford Forge. None of these species were observed on numerous visits to the site during the field studies. Because of the nature of the proposed restoration at Stafford Forge, it is unlikely that any of these three species would be negatively affected. Knieskern's beaked rush was recorded in one location to the north of the northern-most pond, an area that would be little-affected by the proposed restoration. The proposed restoration would not likely either improve or degrade conditions on the site for Cooper's hawk.

3.5.2.7 Wetlands

As mapped in the environmental testing report (Harriott and Southerland 2001), a total of approximately 321 acres of freshwater wetlands exist at the Stafford Forge site. Vegetated wetlands include shrub/scrub-Atlantic white cedar; Atlantic white cedar, and shrub/scrub

wetlands (136.43 acres). Open water (non-vegetated) types include open water/stream (184.57 acres). The vegetated on-site wetlands appear to be of relatively high quality, with few invasive plant species; they are likely of high habitat value to terrestrial wildlife. Atlantic white cedar wetlands are an increasingly rare, ecologically-important wetland type in New Jersey. The Atlantic white cedar wetlands on the Stafford Forge site are relatively large, undisturbed, and appear to be in relatively good condition.

3.5.2.8 Air Quality

There are several air monitoring stations in southeastern New Jersey. The Edwin B. Forsythe National Wildlife Refuge, extending along the Ocean County coast, monitors ambient ozone and sulfur dioxide concentration. Carbon monoxide, total particulates, and lead are monitored at an Atlantic City, New Jersey station; another station in Millville, New Jersey monitors nitrogen oxides (USACE 2001).

The U.S. Environmental Protection Agency (USEPA) has reported that ozone levels within Ocean County persistently exceed national air quality standards, causing the county to be classified as a non-attainment area for ozone. All other pollutants listed by USEPA are currently in attainment status (USACE 2001).

3.5.2.9 Hazardous, Toxic & Radioactive Waste

In accordance with ER 1165-2-132, entitled *Hazardous, Toxic and Radioactive Wastes (HTRW) Guidance for Civil Works Projects*, dated 26 June 1992, investigations must be conducted to assess the existence, nature and extent of HTRW within a project impact area (Comprehensive Environmental Response, Compensation, and Liability Act [CERCLA], 42 U.S.C. > 9601 et seq., as amended). Hazardous substances regulated under CERCLA include "hazardous wastes" under Section 3001 of the Resource Conservation and Recovery Act (RCRA), (42 U.S.C. 6921 et seq.), "hazardous substances" identified under Section 311 of the Clean Water Act (33 U.S.C. 1317); "hazardous air pollutants" designated under Section 112 of the Clean Air Act (42 U.S.C. 7412); and "imminently hazardous chemical substances or mixtures," upon which USEPA has taken action under Section 7 of the Toxic Substance Control Act (15 U.S.C. 2606).

To comply with the HTRW sections as mandated under CERCLA, Environmental Data Resources (EDR) was retained to conduct assessments of the potential presence of hazardous, toxic, or radioactive waste at the six Barnegat sites. Several sources of data were consulted to complete the HTRW evaluation and to determine the potential for encountering on-site hazards. Each assessment by EDR included searches of Federal and state data bases; CERCLIS and NPL data bases; RCRA data bases; the ERNS data base; the CORRACTS data base; the SPL data base; permitted solid waste disposal; state UST and LUST sites; as well as other data sources.

Existing data base information (as well as site observations during the ecological field studies) suggests little potential for encountering hazards on the Stafford Forge site. The EDR report also indicates that there are no potential hazards on any directly adjacent properties. Two records for closed sanitary landfills were mapped by EDR within one mile of the Stafford Forge WMA site (both sites on Stafford Forge Road). The data indicate that both were municipal landfills that are

now closed. These two mapped closed landfill sites are not likely to have any negative effect on the proposed restoration at the Stafford Forge site.

3.5.2.10 Water Resources

Surface water quality was measured at eight locations on the Stafford Forge site and within the near watershed (refer to Harriott and Southerland 2001); Table 3-7 presents results. In addition, physical stream habitat assessments were conducted at two locations, one in the headwaters of Westecunk Creek, and another on Westecunk Creek immediately below the site.

Several items of note were discovered during the water quality data collection in the vicinity of the Stafford Forge site. The pH of Westecunk Creek was always acidic; it was less than 5.0 throughout the area of the site, and was less than 4.0 in some areas of the headwaters. The water temperature in the headwaters of the creek was relatively cold (at about 14°C), and could be considered a cool water system; flow was also relatively swift. Not surprisingly, the water temperature was significantly warmer in the large, relatively shallow ponds on the site. Water temperature about 2 miles downstream of the Stafford Forge site was five degrees cooler, but was relatively the same pH. No eutrophication was evident in any of the large ponds on the Stafford Forge site.

Table 3-7 Results of water quality testing done at the Stafford Forge site for the Barnegat Environmental Testing field studies (as originally presented in Harriott and Southerland 2001).

Sampling Location	pH	Salinity (o/oo)	D.O. (mg/L)	Specific Conductivity (mS/cm)	Temp (C°)	Turbidity (NTU)
W1 (Governors Branch, above site at Route 539; surface)	4.21	0.01	9.81	0.034	14.14	18.8
W2 (Westecunk Creek, above site off Sims Place Road; surface)	3.77	0.02	8.48	0.045	13.85	18.2
W3 (Westecunk Creek, immed. below Pond 1; surface)	4.22	0.01	9.68	0.030	19.71	18.5
W4 (Pond 1, SE corner; surface)	4.92	0.02	8.61	0.036	22.30	20.4
W5 (Pond 2, SW edge; surface)	4.65	0.01	10.42	0.035	21.37	20.3
W6 (Pond 3, SW edge; surface)	4.73	0.02	10.51	0.037	22.05	18.0
W7 (Westecunk Creek, large berm breach immed. above Pond 1; surface)	4.85	0.01	8.89	0.030	22.65	19.3
W8 (Westecunk Creek, immed. downstream of site; surface)	4.55	0.01	9.84	0.029	22.36	18.7

Physical habitats in the headwaters of Westecunk Creek are of relatively high quality, appear to be well protected within the state Wildlife Management Area, and are generally well buffered from roads and development. They rated "optimal" for epifaunal substrate/available cover, pool variability, sediment deposition, channel flow status, channel alteration, bank stability, vegetative protection, and riparian vegetative zone width categories (Harriott and Southerland 2001). It was noted, however, that green filamentous algae was thick in the reach of stream that was sampled; it is not known whether other upstream reaches also possess the algae, or how the algae affects water quality in the creek. Physical habitats below the Stafford Forge site also rated optimal for most categories of physical habitats, with a few exceptions. Immediately below the site the creek is somewhat channelized (likely caused by the upstream impoundment and the existing roadways, i.e., Stafford Forge Road and the Garden State Parkway), and the riparian vegetative zone is less than an optimal width. Other than those relatively minor factors, the creek possesses relatively optimal physical habitats.

Historical data shows that anadromous fish such as alewife have used this creek, but are limited in migration by water control structures. No seine netting was performed at any of the five large ponds on the site, so no assumptions can be made at this time regarding the status of the pond fishery.

According to the data reported for the USGS Station 01409280 Westecunk Creek at Stafford Forge, the watershed of Westecunk Creek above Stafford Forge Road is 15.80 square miles. The daily streamflow data were collected at this station for 16 years between October 1973 and October 1988, with an additional 17 counts of peak streamflow data between December 1973 and September 1999. Section 2 - Hydraulics and Hydrology, Engineering Technical Appendices, provides representative tabulated and graphical displays of the daily, monthly and annual mean streamflow data, as well as the peak streamflow data.

The following observations can be drawn based on these data and in conjunction with the overall hydrologic characteristics of the project site:

- The mean stream flow variation is low, with an average value of 28 cubic-feet per second (cfs). The annual mean values range from a low of only 19.6 cfs to a high of 44.2 cfs.

- Of the 17 counts of the peak streamflow data recorded, all but five are 110 cfs or lower.

The watershed is largely undeveloped, includes the Stafford Forge WMA, and exhibits hydrologic characteristics that have remained relatively constant over the years, including the period of the USGS data. Consequently, and despite the fact that the daily mean streamflow data collection was stopped in 1988, the data characteristics can safely be assumed to reflect the current conditions reasonably well.

3.5.2.11 Geology and Soil

Field data on site geology and soils was not collected during the environmental testing field studies, as it was deemed not to be pertinent to the proposed restoration. Based on limited observations during many field visits to the Stafford Forge site, however, it is obvious that the site soils are very sandy in nature. This is particularly true within the upland pitch pine/oak forest that surrounds the site, where the pitch pines appear to be growing in loose, dry fine sand. Many areas along the streams and within the site wetlands (particularly the Atlantic cedar wetlands) possess a deep, black organic substrate. These soils types are very typical of similar habitats throughout the Pinelands.

3.5.3 Recreational Facilities

As a state WMA, there are recreational opportunities at this site, including hunting, fishing, and hiking. There are, however, no facilities per se at the site, other than the existing system of ponds and sand/dirt roads. A number of vehicles were observed in different parts of the site during the many visits for the environmental testing field studies. Hunters were observed throughout the Stafford Forge site during deer hunting season in late November/early December. Other people were also observed running their dogs at the site.

3.5.4 Cultural Resources

In preparing the draft Feasibility Study, USACE has consulted with the NJ SHPO and other interested parties in order to assess the potential for historic properties in the project area as required under Section 106 of the National Historic Preservation Act of 1966, as amended, and its implementing regulations, 36 CFR Part 800. Section 106 consultation with the NJ SHPO is continuing and will be concluded prior to any project construction activity. The following brief summary outlines several cultural resources investigations conducted by USACE in the Barnegat Bay area and provides a very general history of the region.

USACE has conducted several cultural resources investigations in the Barnegat Bay region in preparation for possible construction of flood control measures in the Manasquan River Basin, proposed ocean shoreline protection projects along the barrier islands between Manasquan Inlet and Long Beach Island, and maintenance activities associated with the operation of Barnegat Bay Inlet. USACE conducted a Phase 1A cultural resources investigation in 1978 in preparation for inlet dredging, shoreline sand placement and new jetty construction at Barnegat Inlet (Gilbert/Commonwealth, 1979). Researchers identified 13 historic properties in the project area vicinity utilizing records background research and on site field reconnaissance. No prehistoric sites were identified.

USACE has completed four cultural resources studies in the northern Barnegat Bay area. The first study, entitled A Phase 1A Cultural Resources Investigation of the Manasquan River Basin, Monmouth and Ocean Counties, New Jersey (Hunter Research Inc. 1993), generated a cultural resource database for the Manasquan River watershed as a planning tool in the development of flood control improvements in the 80 square mile basin. The second investigation entitled Phase 1A Cultural Resources Investigations, Manasquan Inlet to Barnegat Inlet, Ocean County, New

Jersey (Hunter Research Inc. 1997) compiled existing cultural resource information from archival and historic map sources to identify known and expected historic properties in that coastal area. In addition, a low-tide pedestrian archeological survey was conducted along the shoreline in the northern portion of the project area from Manasquan Inlet to the northern boundary of Island Beach State Park. One possible shipwreck site was identified in the near-shore surf zone.

In the third study, entitled Phase I Submerged and Shoreline Cultural Resources Investigations, Manasquan Inlet to Barnegat Inlet, Ocean County, New Jersey (Dolan Research, Inc. 2001), researchers investigated proposed project offshore borrow areas, submerged near-shore locations, and terrestrial shoreline areas utilizing magnetometer, side-scan, and bathymetric data collection techniques. Nineteen remote sensing targets exhibiting shipwreck characteristics were identified in the submerged portion of the near-shore area. In the fourth study, entitled Supplemental Phase I Submerged Cultural Resources Investigations, Borrow Area "B", Manasquan Inlet to Barnegat Inlet, Ocean County, New Jersey (Dolan Research, Inc., 2001), researchers conducted remote sensing in an expanded portion of offshore Borrow Area B. No significant cultural resources were identified.

USACE completed two cultural resources investigations in the southern Barnegat Bay area in association with proposed ocean shoreline protection activities on Long Beach Island. The first study, entitled Phase I Submerged and Shoreline Cultural Resources Investigations and Hydrographic Survey, Long Beach Island, Ocean County, New Jersey (Hunter Research, Inc., Dolan Research Inc. and Enviroscan, Inc., 1998) discusses the results of near-shore tidal and offshore borrow area investigations. Eleven underwater targets exhibiting shipwreck characteristics were identified. In a follow-up investigation entitled Supplemental Phase IB and Phase II Cultural Resources Investigations, New Jersey Atlantic Coast, Long Beach Island, Ocean County, New Jersey (Dolan Research, Inc., 2001), researchers discuss the investigation of the eleven targets identified in the previous study. Two of the targets were found to be shipwrecks that appear to meet the minimum eligibility requirements for listing on the National Register of Historic Places. The following historical summary is taken directly from the above referenced reports.

The majority of documented prehistoric sites in the Barnegat Bay vicinity are from the Woodland Period and are concentrated around the tidal estuaries of the Barnegat Bay and Manasquan Rivers. Notable features of the archaeology of this area are shell-middens and Native American burials. However, no burials are recorded from the Atlantic shoreline itself. Three prehistoric sites have been documented in Point Pleasant Beach and Ortley Beach, Dover Township. The recent discovery of a Paleo-Indian fluted point in Island Beach State Park is a significant find from this early period along the New Jersey shore. Despite a statewide survey of archaeological resources conducted in the early part of this century and more recent cultural resources investigations, no confirmed prehistoric sites have been identified within the tidal zones of the Bay or ocean shorelines on Long Beach Island itself.

The increasing population of the area in the third quarter of the 19th century led to the establishment of a number of incorporated communities from 1886 onward. These include Bay

Head Borough (1886), Harvey Cedars (1894), Island Beach Borough (1933-1965), Lavallette Borough (1887), Mantoloking Borough (1911), Point Pleasant Beach Borough (1886), Seaside Heights Borough (1913) and Seaside Park Borough (1898).

A review of the historic map coverage of the project area documents the development of the shore from a barely-inhabited barrier island to a fully-developed resort community. At the time of the 1776 Holland Map no settlements or isolated dwellings were shown on the barrier islands. The mainland area is described as "Sandy Barren Deserts", and only one road reached the coast in the project area, opposite Barnegat Inlet. A second inlet, identified as "New Inlet" lay north of Barnegat Inlet in the area of the present Toms River. By 1850, eight individual structures, five of them with owner's names attached, are shown on the island. The New Inlet of 1776 was subsequently renamed Cranberry Inlet but is marked as closed on the 1850 map. It had apparently filled in by about 1812.

The 1872 Beers map shows a minor increase in recreational use of the region. The development of Point Pleasant continues and three roads lead to the shoreline from the Manasquan River area. Numerous hotels and boarding houses shown include the Ocean Hotel and Cook property near the Manasquan River, Chadwick's Hotel in Chadwick, an unnamed hotel in the present Seaside Heights, and Reed's Hotel within the present limits of Island Beach State Park. Three life saving stations are also shown.

An 1878 map shows two planned seaside resort communities in the project area, Lavallette and Seaside Heights, and six life-saving stations, all numbered on the national system and given identifying names. By 1883, a railroad connection ran down the Island from the north as far down as Seaside Park, from where it crossed Barnegat Bay south of Toms River. Since the late 19th century much of the remainder of the coast has been developed. Island Beach State Park was set aside prior to World War II, during which time this area was used for missile development and testing. The park was formally opened in 1959.

Although Barnegat Bay was utilized by local anglers and sportsmen throughout the 19th and 20th centuries, the majority of commercial shipping occurred in the shipping lanes running adjacent to the island's Atlantic Ocean shoreline. Over the centuries numerous ships have been wrecked along New Jersey's 127-mile-long coast line and a great number occurred specifically off Long Beach Island. By the first quarter of the 19th century, volunteer life saving stations had been established in many locations along New Jersey's coast. The first Federal assistance came in 1823, when an appropriation was made for the construction of a lighthouse at Cape May. Following the construction of the Cape May Lighthouse, a series of lighthouses were constructed along the New Jersey shoreline, including the Barnegat Lighthouse Tower and the Little Egg Harbor Light.

Between 1848 and 1878, a total of at least 125 shipwrecks have been documented off the Atlantic coastline between Barnegat Inlet and Manasquan Inlet. A single historic vessel has been archaeologically recorded in the project area. In 1988, the remains of a boat were located at the intersection of the southbound lane of Route 35 with Fielder Avenue in Ortley Beach, about 250 yards west of the shore. The vessel was undated.

The first Federal appropriation for life saving stations in any state occurred in 1848 when $10,000 was set aside to provide for life boats, rockets and the construction of eight life saving stations on the New Jersey coast between Sandy Hook and Little Egg Harbor. The observation towers, small wooden buildings and tiny boats associated with these posts were the only means of defense against the loss of human lives. Initially, there were two life saving stations on Long Beach Island. The first was located at Harvey Cedars and the second near Bond's Hotel. In 1870, Congress provided the first funds for a professional United States Life Saving Service and in 1886, the Federal government inaugurated the policy of manning all stations with paid crews. Lovelady's Island, Harvey Cedars and Long Beach Life Saving Stations still stand today in their original locations. The 1898 U.S. Life-Saving Station #14 at Island Beach State Park is listed on the National Register of Historic Places and the Point Pleasant Beach Coast Guard Station is considered eligible for listing.

3.5.5 Socioeconomic Environment

Little Egg Harbor Township, which is where the Stafford Forge project is located, had a population of 13,333 in 1990. It experienced a 19.6 percent increase in the population in 2000, to 15,945.

3.5.6 Aesthetic and Visual Resources

Numerous vehicles were observed at the Stafford Forge site during many visits to the site, although no anglers were ever observed fishing the site ponds or Westecunk Creek. Hunting at the site is primarily restricted to late fall and early winter. It is apparent, then, that a number of the vehicle occupants come to the site for its aesthetic appeal. The view is generally pleasing across the large ponds from most directions on the site. With the exception of during the hunting season, the site also appears to be relatively quiet and tranquil, and thus a pleasant place to retreat.

3.6 FLAT ISLAND

3.6.1 Physical Setting

The Flat Island site is a former dredged material disposal site located in Long Beach Township, in Barnegat Bay, approximately one mile southwest of Ship Bottom, Long Beach Island, New Jersey. The site is key-shaped, longest from northeast to southwest, and comprises a total of approximately 69 acres (see Figure 3-7). Long Beach Island (LBI) is very visible from the eastern side of the island (approximately 700 feet to the east at the closest point).

3.6.1.1 Physiography and Topography

Barnegat Bay watershed topography varies from rolling to flat. The Atlantic Coastal Plain rises from sea level along the coast to an altitude of about 200 feet in the northwest corner of Ocean County (USACE 2001).

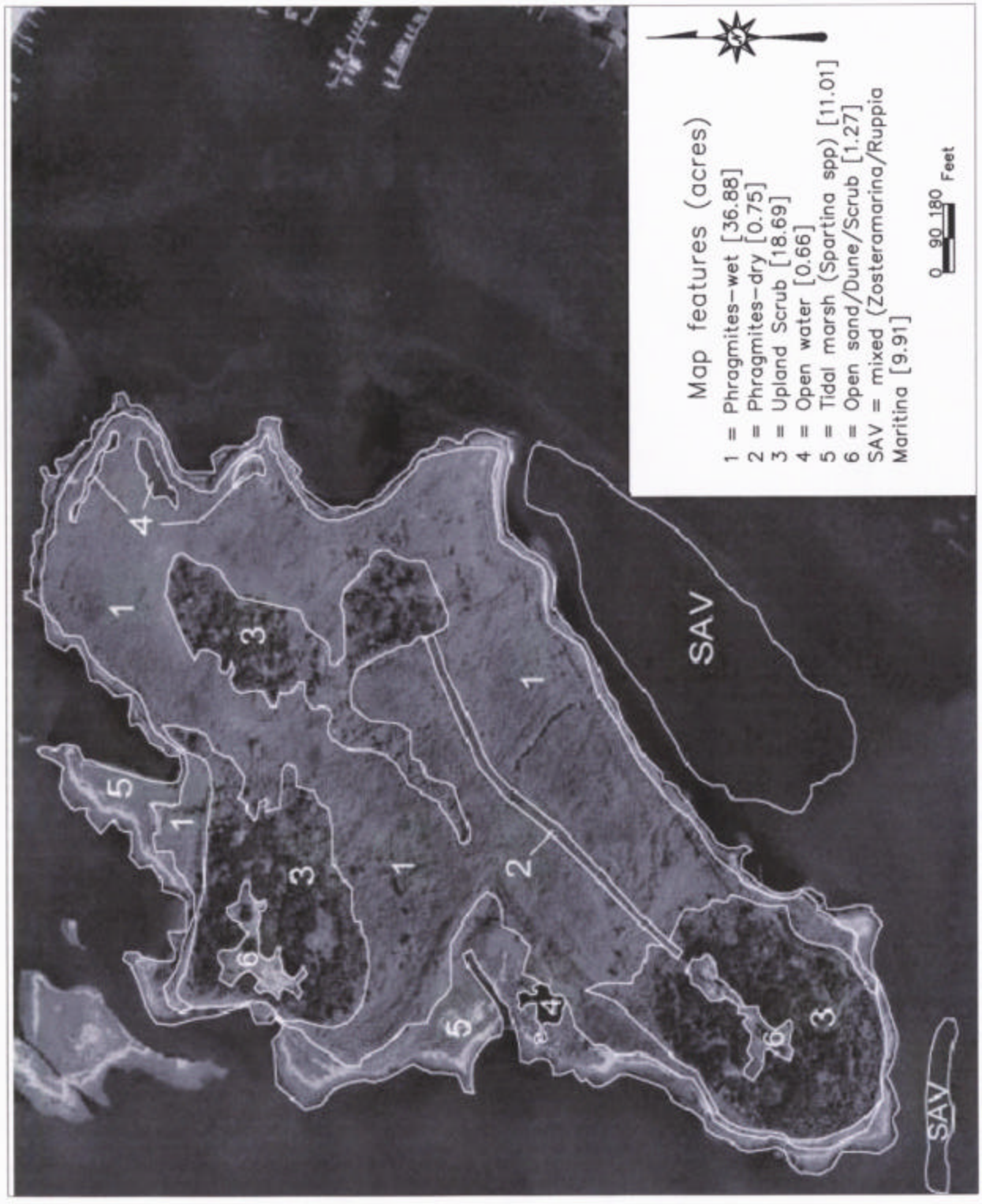


Figure 3-7 Flat Island (Scale 1" – 360')

The terrain in the immediate vicinity of the site is flat (the view is obscured, however, over much of the site owing to the dense phragmites). The Flat Island site is highest in elevation in two places, one on the northwestern end and one on the southwestern end, where open areas of sand, grasses, and scrub are present. Adjoining these high spots are two large parcels and one separate parcel (areas 3) that are close to the vertical elevation of the high spots. According to preliminary surveys performed in early 2002 at the Flat Island site by Andrews, Miller & Associates, vertical elevations vary from about 2 feet NAVD near the small northeastern ponds to about 12 feet at the high point in the northwestern part of the site (AMA 2002).

3.6.1.2 Climate

The climate in Ocean County, New Jersey is continental in nature. Winter temperatures average about 33º Fahrenheit (F), with an average county-wide minimum temperature of 24ºF. The average summer temperature is about 72ºF, with an average daily maximum temperature of 83ºF. Precipitation in the county is well distributed throughout the year; the growing season extends from April through September. About 52 percent of the average annual precipitation, equaling approximately 24 inches, falls during the growing season (USACE 2001).

3.6.1.3 Infrastructure

The Flat Island site is undeveloped and contains no paved roads, buildings, power facilities, rights-of-way, or other anthropogenic infrastructure. Access through most of the site is relatively difficult owing to the dense phragmites cover. No footpaths are currently present at the site. Several dikes constructed for dredged material disposal are present.

3.6.2 Environmental Setting

3.6.2.1 Land Use, Ownership, Management Plans

The Flat Island site is privately owned by the Flat Islands Investors Corporation. The site has been used for the disposal of dredged material within the past 20 years; it possesses a substantial berm around its entire circumference, and another unrelated long one through its center (it is likely this served as a baffle dike). Much of the perimeter dike appears to have been filled to near capacity (it may have also been eroded over time). The baffle dike is still fairly prominent.

Parts of the Flat Island site are needed for future dredged material disposal. Based on several meetings with officials from the NJDEP, Engineering and Construction, and USACE, parts of the eastern half of the site are critically needed for future disposal actions. The NJDEP officials indicated that a large area of the western part of the island could be used for restoration activities, as long as the eastern half is reserved for dredged material disposal. It is thought that the owners of the site apparently also have minor dredged material disposal needs (minor quantities of material resulting from dredging of boat slips and inlets). It is presumed that the eastern side of the island could also accept this small quantity of dredged materials in addition to the larger quantity of NJDEP and USACE-generated materials.

3.6.2.2 Fisheries

Owing to the nature of the project, little information pertaining to fisheries was gathered during field visits to the Flat Island site. The site contains three very small, shallow ponds, all surrounded by dense phragmites (the phragmites was also colonizing parts of the pond interiors). These ponds appeared to have little fisheries value, due to the shallowness and apparent poor water quality (no fish were observed in any of the three ponds). SAV beds were mapped on the southeastern side of the island during the environmental testing field studies, suggesting good habitat for many fish species in the adjacent Bay. Other areas possessing less dense SAV also exist in the Bay around the entire perimeter of the island.

The Flat Island site is adjacent to a large geographic area of Barnegat Bay mapped as Essential Fish Habitat (EFH); no EFH is mapped as part of the site. In its guide to EFH designations in the northeastern United States, NMFS provides a comprehensive summary of EFH designations completed by the New England Fishery Management Council, the Mid-Atlantic Fishery Management Council, the South Atlantic Fishery Management Council, and the NMFS, pursuant to the Magnuson-Stevens Fishery Conservation and Management Act (Act). The 1996 amendments to the Act strengthened the ability of NMFS to protect and conserve the habitat of marine, estuarine, and anadromous finfish, mollusks, and crustaceans. This habitat is broadly defined to include "those waters and substrate necessary to fish for spawning, breeding, feeding, or growth to maturity" (NMFS 1999). Under the Act, the NMFS must coordinate with other Federal agencies that could adversely affect EFH. In turn, NMFS must provide recommendations to Federal and State agencies on such activities to conserve EFH. These recommendations may include measures to avoid, minimize, mitigate, or otherwise offset adverse effects on EFH (NMFS 1999).

3.6.2.3 Benthic Community

There were no benthic invertebrate samples specifically taken at any of the six sites considered under this project. There are data, however, on benthic communities present in the southern part of the Barnegat study area that may be comparable to the communities in other tidal sites. These data were obtained as part of the feasibility study for dredged holes restoration in Barnegat Bay (Scott and Kelley 1999; USACE 2001). The benthic communities at the dredged hole sites are in the same geographic region and in similar estuarine habitats as those being considered under this feasibility study. In general, arthropods, specifically amphipods (small shrimp type crustaceans) and polychaete worms dominated the benthic community. This was true in both seasons, as well as at the different depths. The numerically dominant amphipods were in the genus *Ampelisca* spp., while the numerically dominant polychaetes were in the Capitellidae family (i.e., *Mediomastus ambiseta* and *Capitella capitata*). In addition, the majority of the epifaunal species collected from the area were amphipods.

3.6.2.4 Other Wildlife

Wildlife and their signs (tracks, scats, calls, and other identifiable physical evidence) observed at the site while conducting the environmental testing field studies included red fox (*Vulpes*

vulpes), fish crow (*Corvus ossifragus*), mallard duck (*Anas platyrhynchos*), willet (*Catoptrophorus semipalmatus*), sharp-tailed sparrow (*Ammospiza caudacuta*), seaside sparrow (*Ammospiza maritima*), yellow warbler (*Dendroica petechia*), indigo bunting (*Passerina cyanea*), and Fowler's toad.

Several apparently current red fox dens were noted on the northwestern-most high point (area 6). It is not known whether the foxes (assuming there is more than one individual) are permanent or transient residents on the island, or how they got there. It was interesting to note that red foxes were found in similar situations (i.e., high points of island, open sandy areas, etc.) at all of the island sites studied during the site selection process. No dens were present on the other open, sandy area in the southwestern part of the site. Because of the density of the vegetation on all other parts of Flat Island, it is not likely that the foxes use other areas of the site for denning.

Several large, apparently current fish crow nests were observed within the southern-most area of upland deciduous scrub. Several adult crows were present in the vicinity of the nests during several visits to the site (other observers also indicated the presence of the crows near the nests on separate visits to the site). It is interesting to note, however, that despite the presence of these relatively large areas of shrubs and trees, no signs of long-legged wading bird (i.e., colonial nesting species such as egrets and herons) nesting were observed on Flat Island. This could be owing to the presence of the foxes and other predators (the site is relatively close to Long Beach Island), or other factors.

A few male and female mallard ducks were observed in the largest of the three isolated ponds in the northeastern part of the site. These ponds did not appear to be particularly valuable to wildlife because of their shallowness, their apparently very poor water quality, lack of SAV, and the fact that they were completely "walled-in" (and in places colonized) by very dense phragmites. A pair of willets were apparently nesting in the large area of marsh on the west side during the field studies, and were attempting to use distraction behavior to lead the investigators away from the nest (the nest was not located). Both sharp-tailed sparrows and seaside sparrows were frequently also observed singing in the large area of existing tidal marsh on the western side of the island, and were assumed to be breeding in the vicinity. Several yellow warblers and one indigo bunting were also observed singing at the upland edges of the large marsh. Interestingly, one Fowler's toad was also found on the wet substrate of the large area of marsh.

3.6.2.5 Vegetation and Land Cover

Existing vegetation and land cover were mapped at the Barnegat sites during the environmental testing studies conducted for the project (Harriott and Southerland 2001); this information is subsequently presented on figures in Chapter 5 of this report. The primary vegetation type at the Flat Island site is phragmites marsh (Figure 3-7, area 1). The phragmites marsh is generally monotypic (*Phragmites australis*) throughout, and comprises more than half the vegetation and land cover at the site. The only other species noted frequently was high tide bush (*Iva frutescens*), observed primarily along the outer edges of the phragmites marsh.

The next largest vegetation type at Flat Island is upland deciduous scrub (areas 3). The principal species in the upland scrub are bayberry (*Myrica pensylvanica*), smooth sumac (*Rhus glabra*), winged sumac (*Rhus aromatica*), sassafras (*Sassafras albidum*), poison ivy (*Toxicodendron radicans*), and Virginia creeper (*Parthenocissus quinquefolia*).

The third largest vegetation type at the site is tidal marsh (area 5). Salt marsh cordgrass (*Spartina alterniflora*) and salt hay (*Spartina patens*) are the principal species in the tidal marsh; salt marsh spike grass (*Distichlis spicata*), perennial glasswort (*Sarcocornia perennis*), and common pigmyweed (*Crassula aquatica*) are also locally abundant. The largest area of tidal marsh is on the west side, just below the center of the site. This large, open area of marsh, interspersed with small areas of tidal pools appears to provide valuable habitats (see Wildlife, below).

The high points on the site (areas 6) possess an open sand/deciduous scrub vegetation that is dominated by beachgrass (*Ammophila breviligulata*), switchgrass (*Panicum virgatum*), seaside goldenrod (*Solidago sempervirens*), rugosa rose (*Rosa rugosa*), and winged sumac. As they are adjoining types, the high point open sand/scrub species grade into the upland scrub species in areas 3. Several other smaller vegetation and land cover types were observed at Flat Island.

A long, narrow band of phragmites on uplands occurs on the interior baffle dike (area 2). Other vegetation on the baffle dike included an unidentified blackberry (*Rubus* sp.), pokeweed (*Phytolacca americana*), and poison ivy. Three small areas of largely unvegetated open water were mapped near the northeastern-most part of the site. These small ponds were all partly invaded by phragmites. One other area of open water, a tidal pool, was noted within the large area of tidal marsh in the western part of the site. This pool was largely unvegetated.

SAV was mapped in one large parcel on the southeastern side and another parcel on the southern side. Although the visibility through the water in this area was poor, it was determined that there was an approximately even mixture of both eelgrass (*Zostera marina*) and widgeon grass (*Ruppia maritima*). The SAV in both parcels appeared to be relatively healthy, and was dense to very dense. No other areas of SAV were located in the vicinity of Flat Island.

3.6.2.6 Threatened and Endangered Species

The New Jersey Natural Heritage database indicates that records exist for seven species of concern, including snowy egret (*Egretta thula*), black-crowned night heron (*Nycticorax nycticorax*), little blue heron (*Florida caerulea*), Louisiana heron (*Hydranassa tricolor*), glossy ibis (*Plegadis falcinellus*), yellow-crowned night heron (*Nyctanassa violacea*), and northern harrier (*Circus cyaneus*) at Flat Island. The first five species (i.e., not including yellow-crowned night heron and northern harrier) were part of a minor coastal heron rookery that took place on the island in 1985. The Heritage record for yellow-crowned night heron was from nearly a decade earlier, in 1977. Northern harrier is not a colonial nesting species. Little information is available on the rookery of that year, or whether it also occurred in subsequent years there. Both breeding and non-breeding populations of snowy egrets are state listed as stable and not undergoing any long-term increases or decreases. Breeding populations of black-crowned night

heron are state listed as Threatened; non-breeding populations are stable. Both breeding and non-breeding populations of little blue herons are state listed as stable and not undergoing any long-term increases or decreases. Breeding populations of Louisiana heron are significantly increasing; non-breeding populations are decreasing. Breeding populations of glossy ibis are state listed as declining; non-breeding populations are stable. Both breeding and non-breeding populations of yellow-crowned night heron are state listed as Threatened. Breeding populations of northern harrier are state listed as Endangered; the status of non-breeding populations has not been determined by the state. None of these seven species were observed on Flat Island during the Barnegat field studies. Because virtually all of the existing areas of woody vegetation would be preserved under the proposed restoration plan, no negative effects to its potential use as a coastal rookery by the five listed species (and others) are anticipated. It is possible that the establishment of additional new wetland habitats could help to establish a small coastal rookery on the site.

3.6.2.7 Wetlands

Wetlands were mapped with limited field verification during the environmental testing field studies. As mapped, a total of approximately 48.55 acres of wetlands currently exist at the Flat Island site (in addition, 9.91 acres of SAV were mapped in the adjacent open waters). Refer to the previous Vegetation section for the plant species composition of the wetlands on site. Several of the primary vegetation types on the site comprise large areas of wetlands. The largest vegetation type, phragmites marsh (area 1), is almost entirely wetlands; the third largest vegetation type, tidal marsh (area 5), is also wetlands. Several plant species predominant in these areas including phragmites, high tide bush, salt marsh cordgrass, salt hay, salt marsh spike grass, perennial glasswort, and common pigmyweed. Some tidal pools are present within the tidal marsh areas, which offer excellent habitat for wildlife (refer to previous Other Wildlife section).

3.6.2.8 Air Quality

There are several air monitoring stations in southeastern New Jersey. The Edwin B. Forsythe National Wildlife Refuge, extending along the Ocean County coast, monitors ambient ozone and sulfur dioxide concentration. Carbon monoxide, total particulates, and lead are monitored at an Atlantic City, New Jersey station; another station in Millville, New Jersey monitors nitrogen oxides (USACE 2001).

The U.S. Environmental Protection Agency (USEPA) has reported that ozone levels within Ocean County persistently exceed national air quality standards, causing the county to be classified as a non-attainment area for ozone. All other pollutants listed by USEPA are currently in attainment status (USACE 2001).

3.6.2.9 Hazardous, Toxic & Radioactive Waste

In accordance with ER 1165-2-132, entitled *Hazardous, Toxic and Radioactive Wastes (HTRW) Guidance for Civil Works Projects*, dated 26 June 1992, investigations must be conducted to assess the existence, nature and extent of HTRW within a project impact area (Comprehensive

Environmental Response, Compensation, and Liability Act [CERCLA], 42 U.S.C. > 9601 et seq., as amended). Hazardous substances regulated under CERCLA include "hazardous wastes" under Section 3001 of the Resource Conservation and Recovery Act (RCRA), (42 U.S.C. 6921 et seq.), "hazardous substances" identified under Section 311 of the Clean Water Act (33 U.S.C. 1317); "hazardous air pollutants" designated under Section 112 of the Clean Air Act (42 U.S.C. 7412); and "imminently hazardous chemical substances or mixtures," upon which USEPA has taken action under Section 7 of the Toxic Substance Control Act (15 U.S.C. 2606).

To comply with the HTRW sections as mandated under CERCLA, Environmental Data Resources (EDR) was retained to conduct assessments of the potential presence of hazardous, toxic, or radioactive waste at the six Barnegat sites. Several sources of data were consulted to complete the HTRW evaluation and to determine the potential for encountering on-site hazards. Each assessment by EDR included searches of Federal and state data bases; CERCLIS and NPL data bases; RCRA data bases; the ERNS data base; the CORRACTS data base; the SPL data base; permitted solid waste disposal; state UST and LUST sites; as well as other data sources.

Existing data base information (as well as site observations during the ecological field studies) suggests very little potential for encountering hazards on the Flat Island site. The EDR report also indicates that there are no potential hazards on any directly adjacent properties (i.e., the Bay). All of the listed records are on Long Beach Island, and appear to be relatively minor and of no consequence relating to the proposed restoration actions.

3.6.2.10 Water Resources

The only ecologically significant surface water resources at the Flat Island site are the small tidal pools and the narrow tidal gut within the large existing area of tidal marsh on the western side of the island. These resources, as an integral part of the tidal marsh, provide habitats for wildlife. Included in this suite of wildlife that use the marsh are the increasingly rare sharp-tailed sparrow and seaside sparrow; these species likely breed here.

3.6.2.11 Geology and Soil

Substrate corings taken throughout the site and other measurements indicate that the fill in the highest parts of the site (areas 6) is an average of about 11 feet above the undisturbed marsh encircling the site (these high areas are filled above the top of the perimeter berm); the substrate in this area consists of medium sand. The adjacent areas 3 are about 8 feet above the site's undisturbed marsh (these areas are filled to the top of the berm); all three areas 3 consist of medium sand. The remainder of the site (with the exception of the tidal marsh and open water) is an average of about 2 feet above the site's undisturbed marsh. Groundwater was intercepted at or near the surface in the substrate corings throughout area 1; the substrate throughout this low area is fine silt.

3.6.3 Recreational Facilities

There have been no signs of recreational use by the public at the Flat Island site by boaters, swimmers, fishermen, or wildlife watchers. Limited opportunity exists for wildlife watching on the existing tidal marsh; virtually no opportunity exists in the interior of the island, where tall, dense phragmites impedes foot travel and viewing.

3.6.4 Cultural Resources

In preparing the draft Feasibility Study, USACE has consulted with the NJ SHPO and other interested parties in order to assess the potential for historic properties in the project area as required under Section 106 of the National Historic Preservation Act of 1966, as amended, and its implementing regulations, 36 CFR Part 800. Section 106 consultation with the NJ SHPO is continuing and will be concluded prior to any project construction activity. The following brief summary outlines several cultural resources investigations conducted by USACE in the Barnegat Bay area and provides a very general history of the region.

USACE has conducted several cultural resources investigations in the Barnegat Bay region in preparation for possible construction of flood control measures in the Manasquan River Basin, proposed ocean shoreline protection projects along the barrier islands between Manasquan Inlet and Long Beach Island, and maintenance activities associated with the operation of Barnegat Bay Inlet. USACE conducted a Phase 1A cultural resources investigation in 1978 in preparation for inlet dredging, shoreline sand placement and new jetty construction at Barnegat Inlet (Gilbert/Commonwealth, 1979). Researchers identified 13 historic properties in the project area vicinity utilizing records background research and on site field reconnaissance. No prehistoric sites were identified.

USACE has completed four cultural resources studies in the northern Barnegat Bay area. The first study, entitled A Phase 1A Cultural Resources Investigation of the Manasquan River Basin, Monmouth and Ocean Counties, New Jersey (Hunter Research Inc. 1993), generated a cultural resource database for the Manasquan River watershed as a planning tool in the development of flood control improvements in the 80 square mile basin. The second investigation entitled Phase 1A Cultural Resources Investigations, Manasquan Inlet to Barnegat Inlet, Ocean County, New Jersey (Hunter Research Inc. 1997) compiled existing cultural resource information from archival and historic map sources to identify known and expected historic properties in that coastal area. In addition, a low-tide pedestrian archeological survey was conducted along the shoreline in the northern portion of the project area from Manasquan Inlet to the northern boundary of Island Beach State Park. One possible shipwreck site was identified in the near-shore surf zone.

In the third study, entitled Phase I Submerged and Shoreline Cultural Resources Investigations, Manasquan Inlet to Barnegat Inlet, Ocean County, New Jersey (Dolan Research, Inc. 2001), researchers investigated proposed project offshore borrow areas, submerged near-shore locations, and terrestrial shoreline areas utilizing magnetometer, side-scan, and bathymetric data collection techniques. Nineteen remote sensing targets exhibiting shipwreck characteristics were identified in the submerged portion of the near-shore area. In the fourth study, entitled

Supplemental Phase I Submerged Cultural Resources Investigations, Borrow Area "B", Manasquan Inlet to Barnegat Inlet, Ocean County, New Jersey (Dolan Research, Inc., 2001), researchers conducted remote sensing in an expanded portion of offshore Borrow Area B. No significant cultural resources were identified.

USACE completed two cultural resources investigations in the southern Barnegat Bay area in association with proposed ocean shoreline protection activities on Long Beach Island. The first study, entitled Phase I Submerged and Shoreline Cultural Resources Investigations and Hydrographic Survey, Long Beach Island, Ocean County, New Jersey (Hunter Research, Inc., Dolan Research Inc. and Enviroscan, Inc., 1998) discusses the results of near-shore tidal and offshore borrow area investigations. Eleven underwater targets exhibiting shipwreck characteristics were identified. In a follow-up investigation entitled Supplemental Phase IB and Phase II Cultural Resources Investigations, New Jersey Atlantic Coast, Long Beach Island, Ocean County, New Jersey (Dolan Research, Inc., 2001), researchers discuss the investigation of the eleven targets identified in the previous study. Two of the targets were found to be shipwrecks that appear to meet the minimum eligibility requirements for listing on the National Register of Historic Places. The following historical summary is taken directly from the above referenced reports.

The majority of documented prehistoric sites in the Barnegat Bay vicinity are from the Woodland Period and are concentrated around the tidal estuaries of the Barnegat Bay and Manasquan Rivers. Notable features of the archaeology of this area are shell-middens and Native American burials. However, no burials are recorded from the Atlantic shoreline itself. Three prehistoric sites have been documented in Point Pleasant Beach and Ortley Beach, Dover Township. The recent discovery of a Paleo-Indian fluted point in Island Beach State Park is a significant find from this early period along the New Jersey shore. Despite a statewide survey of archaeological resources conducted in the early part of this century and more recent cultural resources investigations, no confirmed prehistoric sites have been identified within the tidal zones of the Bay or ocean shorelines on Long Beach Island itself.

The increasing population of the area in the third quarter of the 19th century led to the establishment of a number of incorporated communities from 1886 onward. These include Bay Head Borough (1886), Harvey Cedars (1894), Island Beach Borough (1933-1965), Lavallette Borough (1887), Mantoloking Borough (1911), Point Pleasant Beach Borough (1886), Seaside Heights Borough (1913) and Seaside Park Borough (1898).

A review of the historic map coverage of the project area documents the development of the shore from a barely-inhabited barrier island to a fully-developed resort community. At the time of the 1776 Holland Map no settlements or isolated dwellings were shown on the barrier islands. The mainland area is described as “Sandy Barren Deserts”, and only one road reached the coast in the project area, opposite Barnegat Inlet. A second inlet, identified as “New Inlet” lay north of Barnegat Inlet in the area of the present Toms River. By 1850, eight individual structures, five of them with owner's names attached, are shown on the island. The New Inlet of 1776 was subsequently renamed Cranberry Inlet but is marked as closed on the 1850 map. It had apparently filled in by about 1812.

The 1872 Beers map shows a minor increase in recreational use of the region. The development of Point Pleasant continues and three roads lead to the shoreline from the Manasquan River area. Numerous hotels and boarding houses shown include the Ocean Hotel and Cook property near the Manasquan River, Chadwick's Hotel in Chadwick, an unnamed hotel in the present Seaside Heights, and Reed's Hotel within the present limits of Island Beach State Park. Three life saving stations are also shown.

An 1878 map shows two planned seaside resort communities in the project area, Lavallette and Seaside Heights, and six life-saving stations, all numbered on the national system and given identifying names. By 1883, a railroad connection ran down the Island from the north as far down as Seaside Park, from where it crossed Barnegat Bay south of Toms River. Since the late 19th century much of the remainder of the coast has been developed. Island Beach State Park was set aside prior to World War II, during which time this area was used for missile development and testing. The park was formally opened in 1959.

Although Barnegat Bay was utilized by local anglers and sportsmen throughout the 19th and 20th centuries, the majority of commercial shipping occurred in the shipping lanes running adjacent to the island's Atlantic Ocean shoreline. Over the centuries numerous ships have been wrecked along New Jersey's 127-mile-long coast line and a great number occurred specifically off Long Beach Island. By the first quarter of the 19th century, volunteer life saving stations had been established in many locations along New Jersey's coast. The first Federal assistance came in 1823, when an appropriation was made for the construction of a lighthouse at Cape May. Following the construction of the Cape May Lighthouse, a series of lighthouses were constructed along the New Jersey shoreline, including the Barnegat Lighthouse Tower and the Little Egg Harbor Light.

Between 1848 and 1878, a total of at least 125 shipwrecks have been documented off the Atlantic coastline between Barnegat Inlet and Manasquan Inlet. A single historic vessel has been archaeologically recorded in the project area. In 1988, the remains of a boat were located at the intersection of the southbound lane of Route 35 with Fielder Avenue in Ortley Beach, about 250 yards west of the shore. The vessel was undated.

The first Federal appropriation for life saving stations in any state occurred in 1848 when $10,000 was set aside to provide for life boats, rockets and the construction of eight life saving stations on the New Jersey coast between Sandy Hook and Little Egg Harbor. The observation towers, small wooden buildings and tiny boats associated with these posts were the only means of defense against the loss of human lives. Initially, there were two life saving stations on Long Beach Island. The first was located at Harvey Cedars and the second near Bond's Hotel. In 1870, Congress provided the first funds for a professional United States Life Saving Service and in 1886, the Federal government inaugurated the policy of manning all stations with paid crews. Lovelady's Island, Harvey Cedars and Long Beach Life Saving Stations still stand today in their original locations. The 1898 U.S. Life-Saving Station #14 at Island Beach State Park is listed on the National Register of Historic Places and the Point Pleasant Beach Coast Guard Station is considered eligible for listing.

3.6.5 Socioeconomic Environment

The Flat Island project area is located in Long Beach Township. It had a population of 3,329 in 2000. This was a –2.3 percent decrease from the 1990 population, when it was 3,407.

3.6.6 Aesthetic and Visual Resources

The Flat Island site contains a variety of flora and fauna that can be enjoyable to observe; the dominant tall phragmites, however, blocks views in most areas of the site. The views of Barnegat Bay from the high points in the northwestern and southwestern parts of the site are aesthetically pleasing; such views, however, are restricted to only a few small areas with limited access.

4.0 PROBLEM IDENTIFICATION

Identification of ecosystem restoration problems, needs, and opportunities for Barnegat Bay began with the expedited reconnaissance study and continued through Cycles 1 to 3 of the feasibility study (see Chapter 2 - Project History). The reconnaissance study identified the following problems (and associated objectives) for the Barnegat Bay ecosystem:

1. Ecosystem degradation and habitat loss
   - Freshwater wetlands restoration/creation
   - Salt marsh restoration
   - Restoration of abandoned lagoons
   - Submerged aquatic vegetation (SAV) restoration

2. Fish and wildlife ecosystem degradation
   - Restoration of fishery habitat
   - Waterbird habitat restoration
   - Creation/restoration of islands

These restoration objectives were arrived at through discussions with state and Federal natural resource agencies, and are consistent with goals articulated by the Barnegat Bay Estuary Program and other regional plans. It remained for the feasibility study, however, to refine this problem identification by conducting a more detailed analysis of the ecological conditions throughout the ecosystem. Specific conditions denoting significant restoration opportunities needed to be identified and their geographic locations found before plan formulation could begin. As more ecological information on the Barnegat Bay ecosystem was obtained and plan formulation was undertaken, restoration problem identification continued to be refined. Section 4.1 summarizes the problem identification steps undertaken in Cycles 1 through 3, but the reader should refer to their associated volumes (Barnegat Bay GIS Study: Watershed Analysis/Restoration Site Selection Approach Report (Southerland *et al*., 1999), Barnegat Bay Ecosystem Restoration Site Selection (Southerland *et al*., 2000), and Barnegat Bay Ecosystem Restoration Environmental Testing and Restoration Proposals (Harriott and Southerland, 2001)) for more detail. The rest of this chapter describes the methodology developed to identify specific restoration opportunities at individual restoration sites, and includes restoration recommendations to be pursued at each site during plan formulation.

4.1 PROBLEM IDENTIFICATION IN CYCLES 1 THROUGH 3

The USACE ER 1165-2-119, Civil Works Ecosystem Restoration Policy, states that the "purpose of Civil Works ecosystem restoration activities is to restore significant ecosystem function, structure, and dynamic processes that have been degraded." USACE recognizes that ecosystem science and its application to USACE planning is still developing, and it welcomes innovative approaches to problem identification. Therefore, this feasibility study was conceived as a series of cycles that would start at the ecoregional scale appropriate to address the Barnegat Bay ecosystem and would work at successively finer scales to identify appropriate and feasible restoration opportunities.

Because of the considerable geographic breadth and ecological complexity of the Barnegat Bay feasibility study, Cycle 1 (Barnegat Bay GIS Study: Watershed Analysis/Restoration Site Selection Approach Report (Southerland *et al.*, 1999)) included a comprehensive review of available data for the study area and development of a conceptual approach to ecoregional analysis and restoration site selection. This conceptual approach included 15 steps focusing on evaluating available spatial data, assigning ecological conditions to these data, conducting field visits to verify conditions, and using criteria to identify problem types and restoration opportunities. The final steps in the approach were field investigations of candidate sites and evaluation of field results using standardized values to develop priorities. Close coordination with data sources and other interested parties was also part of the approach.

Cycle 2 (Barnegat Bay Ecosystem Restoration Site Selection (Southerland *et al.*, 2000)) was the implementation of the ecoregional analysis and restoration site selection approach. The goals of this cycle were to identify the following (per EC 1105-2-210):

- resources of interest,
- output or anticipated change to be achieved as a result of the restoration measures applied,
- location within the study area in which the restoration measure will be effective, and
- period of time over which the restoration will be accomplished

Consistent with USACE policy, the focus on ecosystem restoration was on those ecological resources and processes that are directly associated with, or directly dependent upon, the hydrological regime of the ecosystem. The issues of water quality and nonpoint source pollution were considered to the extent that they bear on the success of USACE restoration plans, but were not the focus of restoration planning because their control is outside the mandate of the USACE.

In Cycle 2, Geographic Information System (GIS) overlays were used to identify degraded ecological conditions that could reasonably be improved through existing restoration technologies for the following situations: tidal and nontidal wetlands, abandoned lagoons, submerged aquatic vegetation, island for bird habitat, fish passage, and dredged holes. This GIS analysis, coupled with resource agency and public outreach, identified 120 candidate restoration sites. Each of these 120 sites was investigated and field results evaluated using standardized scoring of site-specific benefits (to existing vegetative communities; wildlife; rare, threatened, and endangered species; and anadromous fish passage), area-wide benefits (based on adjacency to other restoration sites and presence of other sites in the same subwatershed), probability of success, and economic feasibility. Based on the combined scores within each restoration type, the following 23 individual sites were judged to provide the best restoration opportunities:

- Tidal wetlands: 3 North Westecunk Creek sites, 3 South Westecunk Creek sites, Barnegat Lighthouse, Oyster Creek
- Non-tidal wetlands: Stafford Forge, Cedar Run, Ballanger Creek, Silver Lake
- Abandoned lagoons: F-cove Lagoon, L-cove Lagoon, Bayville Lagoon
- Islands: High Island, Cedar Bonnet Island, Island 26A, Flat Island

- Fish Passage: Double Trouble Dam
- Submerged Aquatic Vegetation: Northern Site, Central Site, Southern Site

Cycle 3 (Barnegat Bay Ecosystem Restoration Environmental Testing and Restoration Proposals (Harriott and Southerland, 2001)) was conducted to refine further the understanding of the restoration problems and opportunities at these 23 sites by performing intensive field investigations at each. Note that the three SAV restoration sites were not investigated further when it was determined that additional research was necessary to develop SAV restoration plans with reasonable certainty of success. The remaining 20 sites were sampled for a variety of environmental variables, including vegetation and land cover, water quality, site-specific topography and other measurements, wildlife, and physical stream habitat. These investigations were focused on identifying the resolvable and non-resolvable environmental problems at each site including (1) loss of habitat from filling and dredging activities, (2) loss of habitat from hydrological modifications, (3) invasion of habitats by phragmites, and (4) degradation of water quality. Each of these problems is associated with established restoration technologies and constraints; for each site a detailed restoration concept, potential environmental impacts, and estimated costs were identified. The final step in Cycle 3 was coordination with state and Federal natural resource agencies. Table 4-1 below summarizes anticipated benefits and associated constraints with each of the 23 potential restoration sites. Based on the consensus of involved parties, six restoration projects were designated (note that some individual sites were combined into single restoration projects) as high priority.

4.2 CYCLE 4 CONCEPTUAL DESIGN ALTERNATIVES

The final step in problem identification was to develop a methodology for identifying the specific problems, needs, and opportunities at the six high priority sites. While the early steps successfully identified the resources of concern and their locations, this step focuses on identifying the output or anticipated change to be achieved as a result of the restoration. The following sections in this chapter discuss (1) the methodology for site-specific problem identification, (2) the resource-specific needs (in terms of habitat preferences), (3) existing ecological conditions at each site (i.e., habitat units currently available), and (4) recommendations (opportunities) for increasing habitat units to meet resource needs.

Table 4-1 Summary of anticipated benefits and associated constraints for 23 restoration sites identified in Cycle 3 (Barnegat Bay Ecosystem Restoration Environmental Testing and Restoration Proposals report). This summary table is based on information gathered in the feasibility study, especially discussions held with interested agencies through 27 June 2001. Each of the 23 sites was assigned to one of five categories: high priority, medium priority, low priority, unranked (all SAV sites), or deleted (Silver Lake). One high priority project, and two medium priority projects, were created from combinations of two to three adjacent sites. The six high priority projects were carried forward to the completion of problem identification and into plan formulation.

SITE	ANTICIPATED BENEFITS	ASSOCIATED CONSTRAINTS
HIGH PRIORITY PROJECTS		
Barnegat Lighthouse (TWS39)	This site would provide important resources for the Federally listed piping plover that are now rare in the region. Both the anticipated benefits and the likelihood of success (based on project simplicity and consistency with other activities at the site) are high.	The dynamic nature of the site would require maintenance of connecting channel(s) and activities on the site would require construction of small bridges over these channels.
F & L Abandoned Lagoons (LAN05 and LAN06)	These sites were combined into a single project that would provide significant habitat for juvenile fish, benthos, and diamondback terrapins. Returning more natural depths and flows would improve water quality and return this highly degraded system to a more natural state. It is likely that dredged material for filling the lagoons is available from a nearby source.	The F-cove lagoon is heavily used by boaters, but restricting access to the site is being considered by the site owner (USFWS). Concerns about affecting two areas of freshwater wetlands have been alleviated by modifying the restoration concept.

Table 4-1 Cont'd

SITE	ANTICIPATED BENEFITS	ASSOCIATED CONSTRAINTS
Bayville Abandoned Lagoon (LAC02)	Like the similar F-cove and L-cove lagoons, this project would provide significant habitat for juvenile fish, benthos, and black duck. Returning more natural depths and flows would improve water quality and return this highly degraded system to a more natural state.	An NJDEP wetland dredge/fill permit (possibly an Individual Permit) may be necessary to construct the small southeast channel through phragmites wetlands.
Stafford Forge (NWS02)	The prospect of attaining fish passage is very good at Stafford Forge. Such passage could open a large watershed area currently unavailable to anadromous and catadromous species. The partial draining of Ponds #2 and #3 to encourage rooted emergent wetland vegetation would also likely provide good feeding habitats for waterfowl.	The installation of necessary water control structures and culverts could be somewhat complicated, particularly with the addition of fish ladder facilities. Concerns about affecting existing valuable habitats (e.g., for the Pine Barrens tree frog) have been alleviated by eliminating the forested wetlands component of the restoration concept.
Flat Island (ISS02)	This project has the best existing high quality tidal marsh among the island sites, which would be expanded through restoration to produce a significant area of near-natural marsh. The project would also enhance forested and shrub habitats, encouraging the nesting of long-legged wading birds.	A substantial portion (perhaps more than half) of the approximately 70-acre island might be required for future disposal of dredged material. The restoration concept, however, could accommodate this need and still meet the restoration goal. The site is currently in private ownership and support needs to be established.

Table 4-1 Cont'd

SITE	ANTICIPATED BENEFITS	ASSOCIATED CONSTRAINTS
Oyster Creek (TWC21)	This site provides a large area of dense phragmites marsh that could be restored to near natural tidal marsh conditions, improving ecosystem functioning and wildlife habitat. Successful re-establishment of the tidal cycle at the site could be used in place of more invasive methods of restoration, such as herbicides, burning, and re-planting of the marsh.	The site is currently in private ownership and support for the project needs to be established. An NJDEP wetland dredge/fill permit (possibly an Individual Permit) might be necessary to construct in the phragmites wetlands.
MEDIUM PRIORITY PROJECTS		
Island 26A (ISS08)	The creation and maintenance of long-legged wading bird habitats at this site would be ecologically beneficial. The project would be relatively easy to implement.	This site is critical for future disposal of dredged materials by the State. It is possible that the project could be implemented as part of normal disposal operations, independent of the USACE restoration process.
N. Westecunk Creek (TWS15)(TWS17)(TWS18)	These three related northern Westecunk Creek sites present a good opportunity for ecological improvement by returning fill areas to tidal marsh conditions. The benefits, however, would be smaller than those of other projects given that the area restored would be small relative to the large extent of existing freshwater tidal marsh in the area.	The project might entail costs of disposal, since it only involves fill removal. It is possible that the removed fill could be sold as landfill cap material or for other uses. It is possible that NJDEP could undertake all six Westecunk Creek projects as part of normal disposal operations, independent of the USACE restoration process. The project would not likely be attractive as nesting sites for long-legged wading birds.

Table 4-1 Cont'd

SITE	ANTICIPATED BENEFITS	ASSOCIATED CONSTRAINTS
S. Westecunk Creek (TWS 23)(TWS 24) (TWS 25)	These three related southern Westecunk Creek sites present a good opportunity for ecological improvement by returning fill areas to tidal marsh conditions. The benefits, however, would be smaller than those of other projects given that the area restored would be small relative to the large extent of existing freshwater tidal marsh in the area.	The project might entail costs of disposal, because two sites involve moving existing materials only (TWS23 and TWS24), and one involves material removal only (TWS25). There may be a need for future disposal in this area. It is possible that NJDEP could undertake all six Westecunk Creek projects as part of normal disposal operations, independent of the USACE restoration process. The project would not likely be attractive as nesting sites for long-legged wading birds.
High Island (ISS03)	The creation of open, sandy habitats for diamondback terrapins and long-legged wading birds would be ecologically beneficial. The project would likely be relatively easy to implement. The size of the created habitats on the island would be fairly small.	A relatively large amount of dredged material would have to be placed on the island to create the desired open, sandy habitats. The island is still in private ownership and support would have to be established.
Cedar Bonnet Island (ISS02)	This project could provide two new relatively valuable upland sandy habitats for diamondback terrapins, as well as two new areas of tidal wetlands. Both the sandy and tidal wetlands habitats, however, would be relatively small.	Because the proposed project would not involve disposing of new dredge material, it does not meet disposal needs in the area.

Table 4-1 Cont'd

SITE	ANTICIPATED BENEFITS	ASSOCIATED CONSTRAINTS
Double Trouble Dam (33-17)	This project could provide a valuable opportunity for anadromous and catadromous fish passage (depending on the effects of low pH). Only one fish passage structure would likely be required at this site.	The agencies discussed the fact that the upper watershed pH is very low and perhaps marginal for successful establishment of an anadromous fishery. More research is needed before it can be concluded that this project is likely to succeed.
LOW PRIORITY PROJECTS		
Cedar Run Abandoned Cranberry Bog (NWS01)	The site could be restored to historic ecological conditions with likely benefits to the local ecosystem. Specifically, the project would restore the stream corridors and Atlantic white cedar wetlands, as well as an anadromous fishery.	There are existing habitats of significant ecological value on this site, i.e., some uncommon species are present. While the proposed projects would be designed to improve overall conditions at the site, these existing habitats could be affected.
Ballanger Creek (TWS02)	The site could be restored to historic ecological conditions with likely benefits to the local ecosystem. Specifically, the project would restore the stream corridors and Atlantic White Cedar wetlands.	There are existing habitats of significant ecological value on this site, i.e., some uncommon species are present. While the proposed projects would be designed to improve overall conditions at the sites, these existing habitats could be affected.

Table 4-1 Cont'd

SITE	ANTICIPATED BENEFITS	ASSOCIATED CONSTRAINTS
UNRANKED PROJECTS		
SAV Sites (SAN02)(SAC07)(SAS18)	The restoration of SAV habitats is recognized as very important for improving the ecological conditions of Barnegat Bay.	Restoration of SAV remains uncertain. Too little is known about how wasting disease, water quality, and other factors affect planting success to justify project implementation. As more information is gathered and the likelihood of success increases, USACE may consider pursuing these projects.
DELETED PROJECT		
Silver Lake (NWS03)	Based on the 23 August 2001 field visit by USACE, Versar, and AMA to this site, it was determined that this project is no longer necessary to implement fish passage on Westecunk Creek (i.e., as a component of the Stafford Forge restoration). Part of the concrete structure that was in the creek is now missing, eliminating the downstream drop (i.e., fish blockage). Fish passage upstream appears feasible without implementing this project.	Not applicable.

4.3 METHODOLOGY OF PROBLEM IDENTIFICATION FOR INDIVIDUAL SITES

USACE EP 1165-2-502, Ecosystem Restoration – Supporting Policy Information, states that "Rather than limiting objectives to habitat for a single species or resource commodity, such as mallard ducks or bass harvest, ecosystem restoration initiatives will consider interrelationships of

plant and animal communities and their habitats in a larger ecosystem context." Consistent with this policy, the Barnegat Bay feasibility study has undertaken an ecosystem approach to problem identification through the study cycles. The basis of this approach has been to identify areas of degraded ecological condition, that can feasibly be restored to high ecological integrity as represented by pre-human disturbance reference conditions. In order for the problem identification to be specific enough for implementation, however, we recognized the need to use species habitat preference information. As also stated in EP 1165-2-502, "Single species habitat models may be limiting if used to optimize for a particular species, but they can be useful when carefully applied in the ecosystem context in which the habitat is situated."

Therefore, a total of eight species or suites of species (including songbirds, waterfowl, shorebirds, migratory fish, terrapin, and benthic invertebrate communities) were selected to represent the habitat problems and restoration opportunities at each of the six project sites. Each of these species or suites of species are in need of conservation within the Barnegat Bay watershed. The declining status and rarity of these species are a consequence of human disturbance that has degraded the original natural, high ecological integrity conditions of Barnegat Bay and elsewhere. Restoration of these species populations is a useful surrogate for restoration of the degraded ecosystem to the structure and function of a healthy ecosystem. More specifically, the absence or poor condition of habitats preferred by these species can be addressed by restoration actions. Implicit in this ecosystem approach is the fact that the benefits resulting from the proposed restorations would not be limited to these selected species. Other fish and other wildlife species would benefit and, in addition, many ecosystem-level benefits, such as improvement of Barnegat Bay water quality, increased connectivity of native habitats, and more natural ecological processes (e.g., hydrology and nutrient cycling), would also result from the proposed restorations.

Selecting species in need of conservation for habitat evaluation is a more accurate means of developing habitat needs for ecosystem restoration than is the use of common species. Common species often persist in degraded conditions and are less useful indicators of high ecological integrity. While using common species would permit the application of standard Habitat Evaluation Procedures (HEP), this is not required by Corps policy. Therefore, a customized habitat assessment procedure was developed for this feasibility study as follows.

For each of the eight species or suites of species, habitat preferences are described below. These habitat preferences and other critical ecological considerations were taken from existing USFWS Habitat Suitability Index (HSI) models (if available), and from the general scientific literature. These habitat preferences consider shelter, feeding, and reproduction needs of each species and are based primarily on vegetation and physical features discernable though field studies and on aerial photographs. They form the basis for delineating habitat units at each site.

Each habitat unit (derived as 1 acre of preferred habitat for each species or suite of species) is defined as the total ecological benefits for which each restoration project is designed, i.e., 1 acre of high ecological integrity habitat. Creation of lesser quality habitat (fractional habitat units) as a result of implementing the restoration design would likely be minimal. These minor habitat changes would also be consistent across alternatives and thus would not affect incremental cost

analysis or the choice of the preferred alternative. Where applicable (e.g., for fish and duck habitat at Stafford Forge), the restoration of different kinds of habitat at a site will be equally weighted in the analysis.

The numbers of habitat units currently present at each site (as derived from existing vegetation and land cover) reflects the degree of degradation at each site and indicates the potential for creating new habitat units as part of the restoration. The comparison of restoration alternatives at each site will use evaluation of the number of new habitat units created as the measure of overall environmental improvement. Incremental cost analysis will use both the habitat units created and the costs of each alternative to identify cost-effective options and best buys for each project (refer to Chapter 5, Plan Formulation).

4.4 PROBLEMS, NEEDS AND OPPORTUNITIES

Based on the methodology described above, specific problems, needs, and opportunities for ecosystem restoration were identified for each of the six high priority projects. The following subsections present (1) the habitat preferences for selected representative species, (2) the habitat units (based on these preferences) currently present at each project site, and (3) recommended restoration concepts (opportunities) to realize significant ecological benefits at each project site by increasing desired habitat units.

4.4.1 Habitat Preferences of Representative Species

The following text briefly summarizes the habitat preferences of representative species or suites of species at each of the six project sites. Other critical ecological considerations relevant to restoration for each of the species and suites of species (e.g., evidence of declining status and adverse effects of historical changes) are also included.

4.4.1.1 Piping plover

Site: Barnegat Lighthouse

Habitat Preferences. Piping plovers *(Charidrius melodus)* prefer to nest in habitats where herbaceous vegetation covers less than about 30 percent of the area; courtship and nesting sites must be closely monitored to prevent intrusion from humans and their pets (personal communication, D. Jenkins of NJDEP to Versar, 2000). Although not proven, the presence of intertidal feeding areas directly adjacent to breeding sites (i.e., within about 150 feet) will likely greatly improve breeding success (personal communication, D. Jenkins of NJDEP to Versar, 2000).

The piping plover is Federal listed under the Endangered Species Act as threatened and is state listed by NJDEP as endangered. It is considered very rare and localized throughout its naturally-occurring range, making it vulnerable to extinction. The population of this beach-nesting species was greatly reduced around 1900 by uncontrolled shooting (Tyler 1929). The population partly recovered, but is apparently in trouble again because of conflicts with humans on the sand beaches and dunes that it requires for breeding. Breeding censuses from 1969 to 1991 show a

downward trend at an average annual rate of about 5% (a two-thirds decline in 22 years), from what was already a small population (Hess *et al.* 2000). Cairns and McLaren (1980) estimated the entire east coast population as 910 pairs at most. Only a few breeding areas currently exist in New Jersey, including Barnegat Lighthouse and Cape May Meadows.

4.4.1.2 Marsh wren

Sites: Oyster Creek, Flat Island

Habitat Preferences. The following habitat features are identified in the HSI model (Gutzwiller and Anderson 1987) as supporting the marsh wren (*Cistothorus palustris*):

- Emergent wetlands with tall cordgrass, cattail, or bulrush growth form (tall)
- 80% or greater canopy cover of emergent herbaceous vegetation (cordgrasses, cattails, bulrushes); relatively little woody vegetation
- Standing water with minimum depth of 15 cm present

The marsh wren is not formally Federal listed or state listed in New Jersey, but is considered to be declining in some areas within its naturally-occurring range, primarily because of a reduction in habitat (personal communication, D. Jenkins, NJDEP). Historical reports indicated that no other resident land bird suffered as much habitat depletion as the marsh wren during the draining and filling of tidal marshes in New Jersey in the early twentieth century (Stone 1937). The marshes have been changed more recently by the invasion by phragmites. In some cases plants at the edges of the marsh have served as a nest support for the wren (Hess *et al.* 2000), but interior phragmites marsh on large sites likely provides little habitat for the marsh wren. Recent breeding bird surveys have provided no significant trend information, but the marsh wren declined at an average annual rate of 3% per year during the 1966 to 1990 period in the Upper Coastal Plain (which includes New Jersey) (Hess *et al.* 2000).

4.4.1.3 Seaside sparrow

Sites: Oyster Creek, Flat Island

Habitat Preferences. The literature identifies preferred habitat for the seaside sparrow (*Ammospiza maritima*) as salt marshes with dense *Spartina alterniflora, Juncus gerardii,* and *Iva frutescens*. They also occupy wet, muddy parts of the marsh (Rising 1996), as well as cordgrass and *Juncus gerardii* salt marshes that also contain scattered *Iva frutescens* (Stewart and Robbins 1958). The invasion of phragmites and the ditching of salt marsh have adversely affected this species [in Delaware] (Hess *et al.* 2000).

The seaside sparrow is not formally Federal listed or state listed in New Jersey, but is considered to be declining in some areas within its naturally-occurring range, primarily because of a reduction in habitat (personal communication, D. Jenkins, NJDEP). In addition, the Audubon Society and other groups consider the seaside sparrow to be of moderate conservation priority (priority score 21 out of a highest priority score of 30). Audubon specifically identifies a

population decline in the northeast owing to removal of preferred foraging habitat and replacement with vegetation of low food value (i.e., phragmites) (Audubon 2001).

4.4.1.4 Sharp-tailed sparrow

Sites: Oyster Creek, Flat Island

Habitat Preferences. The literature identifies preferred habitat for the sharp-tailed sparrow (*Ammospiza caudacuta*) as salt marshes with dense *Spartina alterniflora, S. patens,* or *Juncus gerardii*, interspersed with small intertidal pools (Rising 1996). They also select wetter marsh than the seaside sparrow (Hess *et al.* 2000). Alteration of marshes (i.e., ditching) has greatly affected this species; phragmites eradication has not adversely affected this species, as it does not use these habitats (Hess *et al.* 2000). Populations of this species appear to be seriously declining (Hess *et al.* 2000).

The sharp-tailed sparrow is not formally Federal listed or state listed in New Jersey, but is considered to be declining in some areas within its naturally-occurring range, primarily because of reduction in habitat (personal communication, D. Jenkins, NJDEP). In addition, the Audubon Society and other groups consider the sharp-tailed sparrow to be of moderate to high conservation priority (priority score 25 out of a highest priority score of 30). Audubon specifically identifies a population decline in the northeast owing to habitat degradation and loss due to draining and diking of salt marshes for development. Audubon acknowledges that the typical small, localized populations of this species make surveying with conventional breeding bird survey methods problematic (Audubon 2001). The species is also particularly secretive, further complicating surveys.

4.4.1.5 River herring

Site: Stafford Forge

Habitat Preferences. The HSI model for river herring (*Alosa pseudoharengus* or alewife and *Alosa aestivalis* or blueback herring) (Pardue 1983) and other literature indicate that these anadromous fish would use stream habitat with the following features:

- Cover. Substrates with 75% silt or other soft materials containing detritus and vegetation.
- Water quality. Spawning temperature range for alewife is 15°C to 20°C; for blueback herring is 20°C to 24°C. Preferred temperature range for alewife 15°C to 20°C; for blueback herring between 20°C and 30°C. Salinity less than 5 ppt. for both. Preferred pH is 5.0 and above
- Food. Zooplankton 100 or more individuals per liter.

It should be noted that the habitat parameters cited in the HSI model would not be affected by the proposed project at Stafford Forge. These parameters are presented here as background. Data relating to these parameters were collected on Westecunk Creek above and below Stafford Forge

by Versar during the Environmental Testing phase of the project (Harriott and Southerland 2001). With the exception of the zooplankton (which were not sampled), all of the habitat requirements for river herring appear to be met. Based on sampling at Lake Pohatcong and Manahawkin Lake in 1999 and 2001 (Versar 2001), it is apparent that the number of zooplankton can vary considerably year to year with natural conditions. Therefore, it appears appropriate that the HSI requirement of 100 or more zooplankton per liter should be viewed as a long-term average, as opposed to a one-time count.

It is not clear if river herring historically used the upper reaches of Westecunk Creek above the town of West Creek; Zich made no mention of historic presence in the summary of his investigations (Zich 1977). Reliable anglers currently living in the area of Westecunk Creek, however, have indicated that they have observed alewife as far north as about 2 river miles below Stafford Forge (at the Silver Lake site, where a former fish blockage once existed but is now removed) (personal communication, W. Tonnesson, NJDEP). These observations suggest a historic annual migration of river herring could have been possible prior to construction of the Stafford Forge cranberry bogs, despite the relatively low pH of the creek.

4.4.1.6 Black duck

Site: Stafford Forge, Bayville Abandoned Lagoon

Habitat Preferences. The HSI model for black duck (*Anas rubripes*) (Lewis and Garrison 1984) indicates that the duck would use wetland habitats with the following features:

- 20% to 30% emergent and forested wetland habitats consisting of ponds, creeks, and impoundments (habitat quality declines when the 30% level is exceeded).
- 80% to 100% of the substrate is occupied by SAV (especially *Potamogeton* and *Ruppia*).
- Snails and other important invertebrates are present in a density of at least 750 per m^2.

The black duck breeding population has apparently declined from its peak historic numbers in some locations in neighboring Delaware (Hess *et al.* 2000). Brood surveys at the Bombay Hook National Wildlife Refuge in Delaware indicate that annual brood production may currently be only one-tenth of the numbers from the 1960s. Other breeding data, however, indicate that large numbers of birds still breed on private lands; breeding success is therefore considered patchy. In addition, there is abundant evidence showing increasing hybridization of black ducks with mallard ducks, with the effect of "mongrelizing" the black duck population. Finally, draining and logging of nontidal wetlands continues to remove some wintering habitat for the black duck (Hess *et al.* 2000).

4.4.1.7 Juvenile fish and benthic assemblages

Sites: F&L Abandoned Lagoons, Bayville Abandoned Lagoon

Habitat Preferences. During field testing, juvenile and adult fish were only captured on the shallow shelf areas of the lagoons in 10 feet of water or less. Because of the very low dissolved

oxygen measured at greater depths and the inappropriate substrate, it is unlikely these fish or other biota use deepwater habitats in these lagoons. Data for a wide variety of fishes indicate that dissolved oxygen levels below about 3.0 mg/L exert significant negative effects on growth and reproduction rates; detectable metabolic changes also occur at dissolved oxygen levels below about 5.0 mg/L (Doudoroff and Shumway 1970). Dissolved oxygen levels were often well below these levels in the L Lagoon and Bayville South Lagoon at depths below about 2 meters during the recent field studies at these sites (Harriott and Southerland 2001). The F Lagoon, however, appeared to possess dissolved oxygen levels of at least 5.0 mg/L, even in most of the deepest areas (Harriott and Southerland 2001). It is not known at this time whether the relatively low temperatures found at depth in the three lagoons during the field studies for environmental testing also negatively affects particular resident fish and benthos.

Experimental gill nets at depth caught no adult fish over an approximately 24-hour period at the F Lagoon during the environmental testing studies, indicating that adult fish may not regularly inhabit the F Lagoon or the L Lagoon (Harriott and Southerland 2001). The waters within the F and L Abandoned lagoons are too deep on average to support SAV. Literature indicates that SAV could potentially establish at depths of 2 to 6 feet in the general area of the Barnegat Bay sites, depending on localized water quality, substrate, and other factors.

Healthy juvenile fish habitats are an integral part of the Barnegat Bay fishery and overall Barnegat Bay ecology. These habitats provide protection and cover, food resources, and other critical resources for juvenile fish and benthic organisms. Such resources are essential for maintaining an overall healthy ecosystem within Barnegat Bay.

4.4.1.8 Diamondback terrapin

Sites: F&L Abandoned Lagoons, Oyster Creek

Habitat Preferences. The HSI model for diamondback terrapin (*Malaclemys terrapin*) (Palmer and Cordes 1988) indicates that they would use habitat with the following features:

- Sandy uplands when shrub cover is less than or equal to 25% are ideal. Shrub cover over 75% renders the site useless; between 25% and 75% shrub cover affects suitability in a linear fashion.
- Grass canopy cover is in the range of 5% to 25%; habitat decreases linearly above and below these percentages. Areas either devoid of grass cover (0%) or completely covered (100%) are considered unsuitable.
- Mean slope of site is less than 7°. Areas with slopes greater than 25° are considered unsuitable. Suitability decreases linearly as slope increases from 7° to 25°.

The diamondback terrapin is not formally Federal listed or state listed in New Jersey. Diamondback terrapins were collected in great numbers as food for humans from around the turn of the century until the late 1920s, and commercial hunters seriously depleted some populations. The "terrapin fad" eventually waned; in most places these turtles have recovered from the extensive exploitation. The continuing alteration of tidal marshes and other estuarine areas,

however, still poses an imminent threat to many existing populations of diamondback terrapins. Mortality of both hatchlings and adults from motor vehicles has generally not been quantified, but may be significant in some areas (Palmer and Cordes 1988). Studies in New Jersey indicated that predators were responsible for egg losses of 51% and 71% in two years; they also took 22% of hatchlings in one year (Burger 1977). Therefore, it appears that terrapin habitats relatively secluded from human disturbances and excessive predation are becoming scarcer.

4.4.2 Habitat Units

Existing habitat units for the selected species and suites of species were derived from both (1) the vegetation and land cover mapping done during Cycle 3 (Barnegat Bay Ecosystem Restoration Environmental Testing and Restoration Proposals) and (2) best professional judgment based on many field visits to the sites by experienced Versar ecologists. Existing habitat units for each of the six sites are presented in Table 4-2.

Table 4-2 Existing habitat units (acres of preferred habitat) for selected species and suites of species (representative of ecological restoration goals at each site), and the overall areal extent of existing vegetation and land cover at the six Barnegat feasibility sites. Quantities of existing habitat units were derived from (1) the vegetation and land cover mapping done for the environmental testing phase of the Barnegat ecological studies (Cycle 3, Harriott and Southerland 2001) and (2) best professional judgment based on many field visits to the site by teams of experienced ecologists.

TABLE KEY **QUANTITY OF EXISTING FISH AND WILDLIFE HABITATS (acres)** **Areal extent of existing vegetation and land cover (acres), including areas of existing desirable habitat**
F&L ABANDONED LAGOONS **FISH AND BENTHIC = 1.0** **DIAMONDBACK TERRAPIN = 0** <u>Existing vegetation and land cover</u> Open water/lagoon = 7.73 (including 1 acre of fish and benthic habitat < 6' deep) Phragmites-wet = 0.98 Phragmites-dry = 0.13 Phragmites-pond = 0.25 Upland deciduous scrub forest = 13.54

Table 4-2 Cont'd

BAYVILLE ABANDONED LAGOON

FISH AND BENTHIC AND BLACK DUCK = 2.0

Existing vegetation and land cover
Open water/lagoon = 3.98 (including 2 acres of fish and benthic and black duck habitat along shallows only)
Phragmites-wet = 5.00
Upland deciduous scrub forest = 8.44
Tidal marsh = 10.18
Dirt road = 0.33

OYSTER CREEK

TIDAL MARSH = 0
(supporting marsh wren, seaside sparrow, sharp-tailed sparrow)

DIAMONDBACK TERRAPIN = 5.0

Existing vegetation and land cover
Open sand = 4.93
Open water = 12.58
Phragmites-marsh = 74.99
Phragmites-scrub = 5.58

BARNEGAT LIGHTHOUSE

PIPING PLOVER = 0.50

Existing vegetation and land cover
Upland dune community = 60.21 (including 0.5 acres of piping plover along water's edge)
Beach (unvegetated) = 9.50
Phragmites = 19.02

STAFFORD FORGE

ANADROMOUS FISHERY = 0

BLACK DUCK (EMERGENT MARSH) = 5.0

Existing vegetation and land cover
Open water = 184.57 (including 5 acres of black duck habitat in shallow water/herbaceous marsh)

Table 4-2 Cont'd

FLAT ISLAND

TIDAL MARSH = 10.0
(supporting marsh wren, seaside sparrow, sharp-tailed sparrow)

Existing vegetation and land cover
Phragmites-wet = 36.88
Tidal marsh = 10.0 (existing high quality marsh)

4.4.3 Recommendations for Habitat Restoration

4.4.3.1 F&L Abandoned Lagoons and Bayville Abandoned Lagoon Restoration Opportunities

These lagoons represent degraded aquatic environments that were once productive salt marsh. Restoration of these lagoons by decreasing water depths would benefit fish and benthic communities. Additionally, the creation of an island, relatively isolated from predators and with sandy nesting habitat, could benefit declining diamondback terrapins. Decreasing lagoon depth at the Bayville Abandoned Lagoon would also allow for establishment of additional new SAV habitats adjacent to the existing SAV; this would likely greatly benefit dabbling waterfowl (such as black duck) by providing larger feeding areas. Under this concept, at F&L Abandoned Lagoons restoration would produce two distinct kinds of habitat units: (1) acres of enhanced vegetated aquatic habitat for fish and benthos and (2) acres of sandy nesting habitat for terrapins. At Bayville South Lagoon, restoration would produce two different kinds of distinct habitat units: (1) acres of enhanced vegetated aquatic habitat for fish and benthos and (2) acres of wetland habitat for ducks.

4.4.3.2 Oyster Creek and Flat Island Restoration Opportunities

Marsh wren, seaside sparrow, and sharp-tailed sparrow are important species that utilize undisturbed tidal marsh habitats and shallow water environments in Barnegat Bay. Each is declining or in low abundance currently. These three species are also representative of the natural wildlife that would greatly benefit from restoration of native salt marsh. This restoration would be achieved by converting existing low-quality phragmites marsh to marsh dominated by native species, thereby increasing the number of acres or native salt marsh habitat units.

4.4.3.3 Barnegat Lighthouse Restoration Opportunities

Because of conflicts with humans on its habitats, piping plovers will likely only survive on public lands with government protection (Hess *et al.* 2000). Creating an intertidal pond adjacent to an existing breeding piping plover population on protected public land would benefit this

species in need of conservation. Under this concept, the restoration would create the acres of pond habitat as the habitat units.

4.4.3.4 Stafford Forge Restoration Opportunities

Stafford Forge is a wildlife management area that would benefit from restoration of two kinds of habitat that have been altered by construction of water control structures: (1) stream habitat for anadromous fish and (2) freshwater wetland habitat for ducks and other marsh species. Passage of river herring over one to three blockages would open stream habitat and return this native species to former habitat. Lowering of water levels in three deep ponds would restore aquatic vegetation and benefit declining species such as black duck. Under this concept, the restoration would produce two kinds of distinct habitat units: (1) acres of on-site aquatic habitat for anadromous fish and (2) acres of shallow wetland habitat. As with all six Barnegat sites with different kinds of habitats, the on-site aquatic habitats and the shallow wetland habitats at Stafford Forge are equally weighted in the analysis. Further, two of the alternatives would also open an additional 10 total stream miles of new habitat for anadromous fish above the Stafford Forge project.

5.0 PLAN FORMULATION

The purpose of environmental planning is to formulate and evaluate an array of cost-effective alternatives which would accomplish various levels of restoration output, and to select a plan to be implemented. As described in Chapter 4, problem identification for the Barnegat Bay Ecosystem Restoration project gathered sufficient inventory information to help refine the restoration objectives, so that plan formulation could begin. In essence, the conceptual plans and habitat restoration recommendations that concluded problem identification also constituted the first steps in plan formulation. Therefore, this plan formulation chapter focuses on the specific alternatives developed for each of the six high priority restoration projects. Each alternative was conceived as a significantly different way to accomplish the restoration objectives.

5.1 METHODOLOGY OF CYCLE 5 PLAN FORMULATION

The alternative plans for the Barnegat Bay ecosystem restoration projects were formulated based on (1) amount of ecological benefits (i.e., degree to which restoration objectives would be met), (2) considerations regarding future uses, (3) technical constraints, and (4) expected costs. Input was solicited and received from several Federal and state resource agencies on potential benefits related to the restoration alternatives, and on potential conflicts and synergies with future uses at each site (both during meetings and through mailings). Surveying, modeling, and engineering analyses were conducted to address the technical feasibility of each alternative. USACE Micro Computer Assisted Cost Estimating System (MCACES) program was used to develop costs for every aspect of each of the proposed alternatives. The general, economic, and environmental criteria used to formulate and evaluate the alternatives are discussed below.

5.2 PLANNING OBJECTIVES

The planning objectives developed to address the problems and opportunities identified during feasibility derive from the general goal of restoring the ecological integrity of the Barnegat Bay ecosystem. These objectives, therefore, represent specific ways to address the problems identified in the reconnaissance study: (1) ecosystem degradation and habitat loss and (2) fish and wildlife ecosystem degradation. Each planning objective includes "(1) specification of the resource(s) of interest; (2) the output or anticipated change to be achieved as a result of the restoration measures applied: (3) location within the study area in which the restoration measure will be effective; and (4) the period of time over which the restoration will be accomplished."

In order to develop feasible plans to meet these goals, planning objectives were developed for specific actions appropriate to each ecosystem type and environmental situation included in the feasibility study, as follows:

- Water quality improvements to achieve fish and benthic habitat improvement over a project life of 25 years (F & L Abandoned Lagoons and Bayville Abandoned Lagoon),
- Terrapin habitat improvements over a project life of 25 years (F & L Abandoned Lagoons and Oyster Creek),
- Tidal marsh restoration over a project life of 25 years (Oyster Creek and Flat Island),

- Creation of intertidal feeding habitats for piping plover over a project life of 10 years (a Federal Threatened and state Endangered species; Barnegat Lighthouse),
- Reintroduction of a river herring and American eel fishery over a project life of 25 years (Stafford Forge), and
- Waterfowl habitat improvements over a project life of 25 years (Bayville Abandoned Lagoon and Stafford Forge).

These restoration objectives are stated as the specific accomplishments needed to restore ecological resources or other ecosystem components. They primarily involve physical alteration of the environment to restore components of ecosystems (i.e., their structure and function), and are described in changes in habitat type and/or quality. Other management measures relevant to each restoration project but outside the purview of USACE (e.g., control of nonpoint source pollution, reducing human recreational activity) are not included in the restoration objectives but may be carried out by the appropriate agencies.

Critical to the implementation of these planning objectives are each restoration project's specifications for increasing habitat units representative of more natural, high ecological integrity conditions, as derived from habitat preferences for selected representative species or suites of species (see Chapter 4). The calculation of projected habitat units for each restoration project are discussed later in this chapter.

5.3 FORMULATION AND EVALUATION CRITERIA

5.3.1 General Criteria

The purpose of the six proposed projects is the sustained ecological restoration of currently degraded wetlands and fish and wildlife habitats. Therefore, the alternatives for each of the proposed projects were formulated to provide long-term environmental benefits, such as improved wetland ecosystem functions and values, greater habitat values for key species of fish and wildlife, and increased water quality. The benefits provided by and costs associated with the projects will be evaluated in accordance with all applicable USACE regulations; every final plan must be complete, efficient, safe for the public, and economically feasible.

5.3.2 Economic Criteria

Per ER 1105-2-100, "The recommended plan should be the justified alternative and scale having the maximum excess of monetary and non-monetary beneficial effects over monetary and non-monetary costs. This plan occurs where the incremental beneficial effects just equal the incremental costs, or alternatively stated, where the extra environmental value is just worth the extra costs. This plan should be called the National Ecosystem Restoration (NER) plan. In making these value and cost comparisons it is assumed that each plan and scale is the minimum cost way of achieving that level of output; i.e., that an appropriate least cost or cost effectiveness algorithm was used in their development. Deviations from the NER Plan require justification."

5.3.3 Environmental Criteria

Throughout the problem identification and plan formulation phases of the feasibility study, environmental criteria are key to developing alternatives that will achieve the goal of sustained ecological restoration of currently degraded wetlands and fish and wildlife habitats. Specifically the alternatives are formulated by optimizing the ecological benefits of restoration plans through the maximizing of desired habitat units within technical and economic constraints. For an alternative to be developed, it has to meet the environmental criteria of making "a significant contribution to addressing the specified restoration problems or opportunities (i.e., restore important ecosystem structure or function to some meaningful degree)" (EC 1105-2-210). For each of the six restoration projects, alternatives were developed that would significantly restore important and valued ecosystem components.

Environmental criteria will also be applied to each alternative to ensure that any adverse environmental effects that might arise from implementing the projects will be avoided or minimized. Specifically, best management practices will be employed during all project construction, including (1) minimization of activity outside the project footprint, (2) use of sediment fences to control runoff, (3) restriction of construction during critical habitat use periods, and (4) design features to preserve existing valuable habitat.

5.4 DESCRIPTION AND DISCUSSION OF ALTERNATIVES CONSIDERED

5.4.1 Identification of Alternatives

Several alternatives, including No Action, were reviewed for each of the six proposed Barnegat Bay ecosystem restoration projects. The following is a site-by-site description of all action and no-action alternatives, with the rationale for each action alternative.

5.4.1.1 F&L Abandoned Lagoons

The restoration goals for this project are to improve habitats for juvenile fish, benthic invertebrates, and diamondback terrapin. The goals would be realized through a combination of decreasing existing lagoon depths to 6 feet, improving water quality (by improving circulation with new tidal connections and decreased depth), and flattening/clearing existing sandy piles on newly created islands (for terrapin habitat). The 6-foot depth would likely provide for the growth of SAV with its attendant benefits for fish and wildlife habitat, as well as water quality. It is likely that reducing the existing lagoon depth, even without an increase in circulation, would increase dissolved oxygen to a level adequate for fish and benthic invertebrates during most of the year. Temperature, however, might increase in the summer (particularly in L Lagoon) as a result of the shallower depths. Greater circulation from the channel(s) proposed for connecting the lagoons would likely ameliorate this temperature effect.

The alternatives differ primarily in the ways and amount of new tidal circulation that would be achieved. Certain alternatives would also provide greater terrapin nesting habitat. Hydrodynamic models of the predicted kinetic energy in the lagoons indicate that Alternatives 3 and 5 would produce the greatest amount of circulation. The higher the kinetic energy is at a

certain location, the higher the level of flow activity will be, leading to more effective circulation and hence better water quality. Based on this analysis, deepening the entrance channel to the L Lagoon would add only a small amount of new circulation (AMA 2002), and therefore would not result in a significant increase in water quality compared to the other alternatives. All of the alternatives would likely also have the secondary benefit of passively converting two areas of phragmites marsh to the native tidal (spartina) marsh (by introducing the tidal influx). The following are the proposed alternatives for the F & L Abandoned Lagoons.

Alternative 1. No Action. The existing conditions at the site would remain unchanged.

Alternative 2. This alternative would improve habitats for juvenile fish, benthic invertebrates, and diamondback terrapin while minimizing new channel excavation to connect the lagoons (Figure 5-1). The alternative would also provide one island of terrapin habitat fully isolated by water, with the material graded essentially flat to maximize terrapin access to the sites. While the new 6-foot depth would improve water quality, this alternative would provide the least additional benefit from increased circulation. This alternative consists of excavating a 270-foot long channel of approximately 400 ft^2 in cross sectional area between the ends of the two prongs of F Lagoon, and a 230-foot long channel of approximately 400 ft^2 in cross sectional area between the middle of the ends of the two prongs of F Lagoon and L Lagoon, as well as filling both lagoons to an average depth of 6 feet. Due to their already shallow depths, the existing shelves along the perimeters of both lagoons will not be included in this filling operation. Also, pilings will be installed at the entrances to the new connecting channels to deter public access. According to the field observations and AMA's supplementary field surveys, the ground elevations between the two lagoon systems vary in the range of +4 to +10 Mean Low Water (MLW). In this area, there is a low-elevation section covered with wet-phragmites and an open water/pond area with phragmites between the two lagoons.

Alternative 3. This alternative would improve habitats for juvenile fish, benthic invertebrates, and diamondback terrapin by excavating new channels to connect the lagoons (Figure 5-2). This alternative would likely provide a greater improvement in water quality (circulation) than Alternative 2, and would provide two islands of terrapin habitat fully isolated by water, with the material graded essentially flat to maximize terrapin access to the sites. This alternative consists of excavating a 270-foot long channel of approximately 400 ft^2 in cross sectional area between the ends of the two prongs of F Lagoon, and two 200-foot long channels of approximately 400 ft^2 in cross sectional area between the ends of the two prongs of F Lagoon and L Lagoon, as well as filling both lagoons to an average depth of 6 feet. Due to their already shallow depths, the existing shelves along the perimeters of both lagoons will not be included in this filling operation. Also, pilings will be installed at the entrances to the new connecting channels to deter public access.


F & L ABANDONED LAGOONS
GRAPHIC SCALE
(IN FEET)
FILL TO 6' DEPTH
FILL TO 6' DEPTH
CHANNEL EXCAVATION
PILES ACROSS ENTRANCES (10)
MAP FEATURES (ACRES)
1 = OPEN WATER/LAGOON (7.73)
2 = UPLAND DECIDUOUS FOREST (13.54)
3 = PHRAGMITES-WET (0.98)
4 = TIDAL MARSH (SPARTINA SPP.) (6.26)
5 = SHALLOW OPEN WATER (0.67)
6 = PHRAGMITES-DRY (0.15)
7 = OPEN WATER/POND/PHRAGMITES (0.25)
F & L ABANDONED LAGOONS - ALTERNATIVE 2
BARNEGAT BAY ECOSYSTEM RESTORATION
FEASIBILITY STUDY

Figure 5-1.


F & L ABANDONED LAGOONS
GRAPHIC SCALE
(IN FEET)
FILL TO 6' DEPTH
FILL TO 6' DEPTH
PILES ACROSS ENTRANCES (20)
CHANNEL EXCAVATION
F & L ABANDONED LAGOONS - ALTERNATIVE 3
BARNEGAT BAY ECOSYSTEM RESTORATION
FEASIBILITY STUDY
MAP FEATURES (ACRES)
1 = OPEN WATER/LAGOON (7.73)
2 = UPLAND DECIDUOUS FOREST (13.54)
3 = PHRAGMITES-WET (0.98)
4 = TIDAL MARSH (SPARTINA SPP.) (5.26)
5 = SHALLOW OPEN WATER (0.67)
6 = PHRAGMITES-DRY (0.13)
7 = OPEN WATER/POND/PHRAGMITES (0.25)

Figure 5-2.


F & L ABANDONED LAGOON
GRAPHIC SCALE
(IN FEET)
FILL TO 6' DEPTH
FILL TO 6' DEPTH
PILES ACROSS ENTRANCES (10)
CHANNEL EXCAVATION
F & L ABANDONED LAGOONS - ALTERNATIVE 4
BARNEGAT BAY ECOSYSTEM RESTORATION
FEASIBILITY STUDY
MAP FEATURES (ACRES)
1 = OPEN WATER/LAGOON (7.73)
2 = UPLAND DECIDUOUS FOREST (13.54)
3 = PHRAGMITES-WET (0.98)
4 = TIDAL MARSH (SPARTINA SPP.) (6.28)
5 = SHALLOW OPEN WATER (0.67)
6 = PHRAGMITES-DRY (0.13)
7 = OPEN WATER/POND/PHRAGMITES (0.25)

Figure 5-3.


F & L ABANDONED LAGOON
GRAPHIC SCALE
(IN FEET)
FILL TO
6' DEPTH
FILL TO
6' DEPTH
PILES ACROSS
ENTRANCES (20)
CHANNEL
EXCAVATION
F & L ABANDONED LAGOONS - ALTERNATIVE 5
BARNEGAT BAY ECOSYSTEM RESTORATION
FEASIBILITY STUDY
MAP FEATURES (ACRES)
1 = OPEN WATER/LAGOON (7.73)
2 = UPLAND DECIDUOUS FOREST (13.54)
3 = PHRAGMITES-WET (0.98)
4 = TIDAL MARSH (SPARTINA SPP.) (6.26)
5 = SHALLOW OPEN WATER (0.67)
6 = PHRAGMITES-DRY (0.13)
7 = OPEN WATER/POND/PHRAGMITES (0.25)

Figure 5-4.

Alternative 4. This alternative would improve habitats for juvenile fish, benthic invertebrates, and diamondback terrapin while minimizing new channel excavation to connect the lagoons, but would also deepen the narrow channel at the northeastern side of the L Lagoon (Figure 5-3). This alternative would likely provide a marginal improvement in water quality (circulation) over Alternative 3; it would also provide one island of terrapin habitat fully isolated by water, with the material graded essentially flat to maximize terrapin access to the sites. This alternative consists of Alternative 2 in addition to deepening the entrance channel to L Lagoon to 6 feet, without widening the existing channel and without disturbing the existing tidal marsh along this channel. Also, pilings will be installed at the entrances to the new connecting channels to deter public access.

Alternative 5. This alternative would improve habitats for juvenile fish, benthic invertebrates, and diamondback terrapin by excavating new channels to connect the lagoons, and would also deepen the narrow channel at the northeastern side of the L Lagoon (Figure 5-4). This alternative would likely provide the greatest improvement in water quality (circulation), and would also provide two islands of terrapin habitat fully isolated by water, with the material graded essentially flat to maximize terrapin access to the sites. This alternative consists of Alternative 3 in addition to deepening the entrance channel to L Lagoon to 6 feet, without widening the existing channel and otherwise without disturbing the existing tidal marsh along this channel. Also, pilings will be installed at the entrances to the new connecting channels to deter public access.

5.4.1.2 Bayville Abandoned Lagoon

The restoration goals for this project are to improve habitats for juvenile fish, benthic invertebrates, and black duck (as well as other dabbling waterfowl). The goals would be realized through a combination of decreasing existing lagoon depths to 6 feet and improving water quality (by improving circulation with new tidal connections and decreased depth). The 6-foot depth would likely provide for the growth of SAV with its attendant benefits for fish and wildlife habitat (e.g., black duck), as well as water quality. It is likely that reducing the existing lagoon depth, even without an increase in circulation, would increase dissolved oxygen to a level adequate for fish and benthic invertebrates during most of the year. Temperature, however, might increase in the summer as a result of the shallower depths. Greater circulation from the channel(s) proposed for connecting the lagoon and the bay would likely ameliorate this temperature effect.

The alternatives differ primarily in the ways and amount of new tidal circulation that would be achieved. Several of the alternatives would likely also have the secondary benefit of passively converting small areas of phragmites marsh to the native tidal (spartina) marsh. Certain alternatives would avoid creation of open channels in the eastern part of the site, and would not convert phragmites marsh in that area. The following are the proposed alternatives for Bayville Abandoned Lagoon.

Alternative 1. No Action. The existing conditions at the site would remain unchanged.

Alternative 2. This alternative would construct a piped channel under an existing dirt road to provide tidal circulation and would avoid creating a channel through existing (though degraded) wetlands on the eastern part of the site. An open channel would be constructed through tidal wetlands and phragmites marsh in the western part of the site (Figure 5-5). This alternative consists of the excavation of an approximately 500-foot long channel with 300 ft^2 in cross section area meandering through the phragmites and tidal marsh areas between the west end of the lagoon and the Bay, installation of up to three 64"x43" elliptical concrete or aluminum corrugated metal arch Corrugated Metal Pipe Arch (CMPA) culvert pipes with end sections (350-foot long each) directly under the existing road, and raising the bottom elevation of the lagoon to an approximate depth of 6 feet. The CMPA culverts would extend into the Bay approximately 50 feet beyond the shoreline to reach the –3.0 MLW contour.

Alternative 3. This alternative would involve construction of an open channel in the eastern part of the site, primarily on the edge of the scrubby upland forest adjacent to the existing dirt road (i.e., it would avoid creating a channel through existing (though degraded) wetlands on the eastern part of the site). An open channel would be constructed through tidal wetlands and phragmites marsh in the western part of the site (Figure 5-6). This alternative consists of the excavation of an approximately 500-foot long channel with 300 ft^2 in cross section area meandering through the phragmites and tidal marsh areas between the west end of the lagoon and the Bay; installation of up to three 64"x43" elliptical concrete or aluminum corrugated metal arch (CMPA) culvert pipes with end sections, 50-foot long each across the road, and a 250-foot long open channel with 70 ft^2 of cross sectional area below MLW and 130 square feet above MLW through the upland forest and very short phragmites area adjacent to and along the eastern side the road. The excavated channel would extend into the Bay approximately 50 feet beyond the shoreline until the –3.0 MLW contour is reached. In addition, raising the bottom elevation of the lagoon to an approximate depth of 6 feet is included.

Alternative 4. This alternative would involve construction of an open channel on the eastern part of the site, through existing phragmites marsh and scrubby upland forest. Another open channel would be constructed through tidal wetlands and phragmites marsh in the western part of the site (Figure 5-7). A secondary (but important) benefit of this alternative would be conversion of some of the phragmites marsh to tidal marsh adjacent to the eastern channel. This alternative consists of the excavation of an approximately 500-foot long channel with 300 ft^2 in cross section area meandering through the phragmites and tidal marsh areas between the west end of the lagoon and the Bay; installation of up to three 64"x43" elliptical concrete or aluminum corrugated metal arch (CMPA) culvert pipes with end sections, 50-foot long each across the road, and a 250-foot long open channel with 70 ft^2 of cross sectional area below MLW and up to 130 square feet above MLW through a short segment of the upland forest and predominantly phragmites area further to the eastern end of the lagoon. The excavated channel would extend into the Bay approximately 50 feet beyond the shoreline until the –3.0 MLW contour is reached. In addition, raising the bottom elevation of the lagoon to an approximate depth of 6 feet is included.


BAYVILLE ABANDONED LAGOON - ALTERNATIVE 2
BARNEGAT BAY ECOSYSTEM RESTORATION
FEASIBILITY STUDY
BAYVILLE ABANDONED LAGOON
GRAPHIC SCALE
(IN FEET)
TRIPLE 64"x43" COATED CMPA CULVERT PIPES, 330' L.F. EACH, WITH CONCRETE HEADWALL AT LAGOON AND PILE BENTS IN BAY.
CHANNEL EXCAVATION
MAP FEATURES (ACRES)
1 = OPEN WATER/LAGOON (3.96)
2 = UPLAND DECIDUOUS FOREST (8.44)
3 = PHRAGMITES-WET (5.00)
4 = TIDAL MARSH (SPARTINA SPP.) (10.18)
5 = DIRT ROAD (0.33)
6 = PHRAGMITES-DRY (0.10)
7 = OPEN WATER/SHALLOW/SAV(RUPPIA MARITIMA)(1.98)

FIGURE 5-5

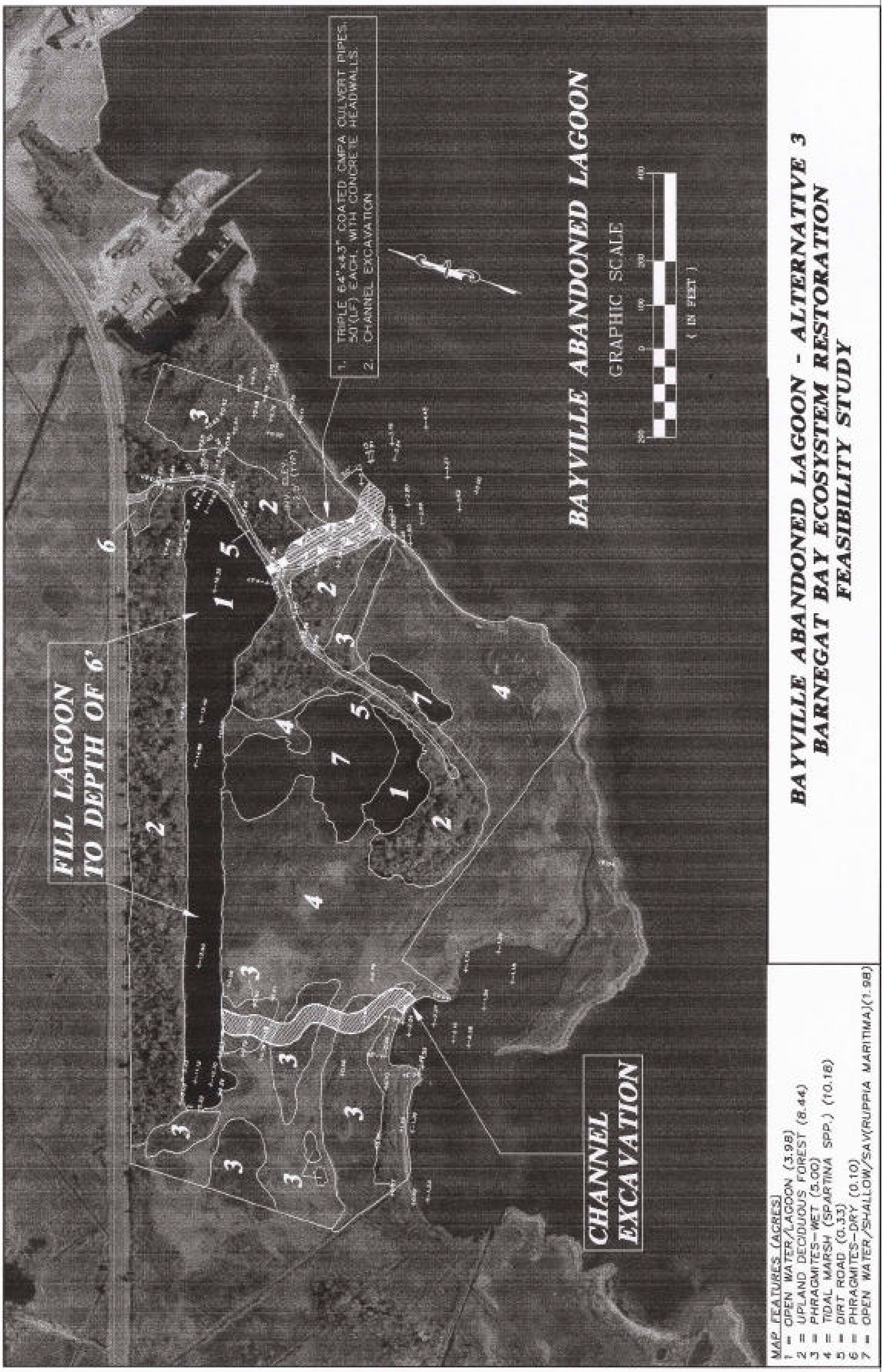

FILL LAGOON TO DEPTH OF 6'
CHANNEL EXCAVATION
1. TRIPLE 64"x43" COATED CMPA CULVERT PIPES, 50'(LF) EACH, WITH CONCRETE HEADWALLS.
2. CHANNEL EXCAVATION
BAYVILLE ABANDONED LAGOON
GRAPHIC SCALE
(IN FEET)
BAYVILLE ABANDONED LAGOON - ALTERNATIVE 3
BARNEGAT BAY ECOSYSTEM RESTORATION
FEASIBILITY STUDY
MAP FEATURES (ACRES)
1 = OPEN WATER/LAGOON (3.98)
2 = UPLAND DECIDUOUS FOREST (8.44)
3 = PHRAGMITES-WET (5.00)
4 = TIDAL MARSH (SPARTINA SPP.) (10.16)
5 = DIRT ROAD (0.33)
6 = PHRAGMITES-DRY (0.10)
7 = OPEN WATER/SHALLOW/SAV(RUPPIA MARITIMA)(1.98)

Figure 5-6

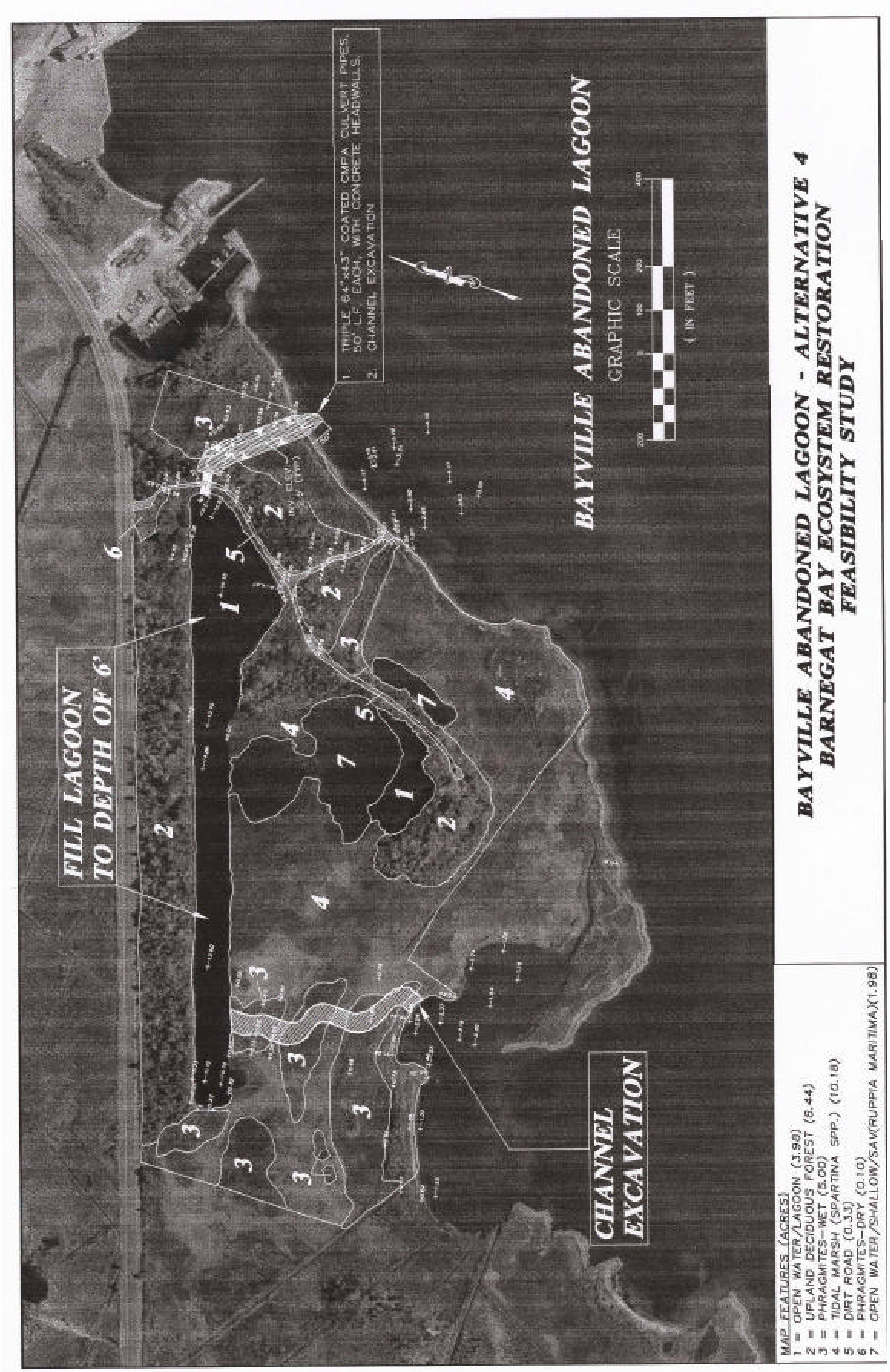

FILL LAGOON
TO DEPTH OF 6'
CHANNEL
EXCAVATION
1. TRIPLE 84"x43" COATED CMPA CULVERT PIPES, 50 LF EACH, WITH CONCRETE HEADWALLS.
2. CHANNEL EXCAVATION
BAYVILLE ABANDONED LAGOON
GRAPHIC SCALE
(IN FEET)
BAYVILLE ABANDONED LAGOON - ALTERNATIVE 4
BARNEGAT BAY ECOSYSTEM RESTORATION
FEASIBILITY STUDY
MAP FEATURES (ACRES)
1 = OPEN WATER/LAGOON (3.98)
2 = UPLAND DECIDUOUS FOREST (6.44)
3 = PHRAGMITES-WET (5.00)
4 = TIDAL MARSH (SPARTINA SPP.) (10.18)
5 = DIRT ROAD (0.33)
6 = PHRAGMITES-DRY (0.10)
7 = OPEN WATER/SHALLOW/SAV(RUPPIA MARITIMA)(1.98)

Figure 5-7

5.4.1.3 Oyster Creek

The restoration goals of the project are to convert large areas of existing monotypic phragmites marsh (poor existing habitat for wildlife) into significant new tidal (spartina) marsh habitats for a suite of marsh birds (marsh wren, sharp-tailed sparrow, seaside sparrow, etc.) and other wildlife. Diamondback terrapins would also benefit from creation of new open, sandy habitats, and protection of existing ones. The goals would be realized by opening the site to tidal, saline Bay water through a system of open channels. All of the channels would be cut primarily through dense, nontidal phragmites marsh, and would incorporate the existing system of small, shallow ponds and deep, large ditches. Clean, sandy materials excavated from the channels would be deposited on the existing semi-open sandy area and adjacent upland phragmites habitats.

The three alternatives differ primarily in the complexity of their proposed channel systems and the extent of high quality tidal marsh that would be created. Technical approaches also differ in the width of channels to be constructed. The following are the proposed alternatives for Oyster Creek.

Alternative 1. No Action. The existing conditions at the site would remain unchanged.

Alternative 2. This alternative (Figure 5-8) would introduce the tidal, saline Bay water onto the site by creation of a single, wide channel that meanders through the site; it would connect the existing series of small, shallow ponds and large ditches. It is likely that this would be the easiest to construct of the three alternatives presented. This alternative consists of the excavation of a meandering and braided open channel system of approximately 80 feet in width at MLW and 2,000 feet in length, connected to the Bay at the east and in the south through 100 foot wide openings provided through the existing timber bulkhead.

Alternative 3. This alternative (Figure 5-9) would introduce the tidal, saline Bay water onto the site by creation of a moderately braided and meandering system of new channels that connect through the existing series of small, shallow ponds and large ditches. This alternative consists of the excavation of a meandering and braided open channel system of approximately 35 feet in width at MLW and 9,400 feet in length, connected to the Bay at the east and in the south through 100-foot wide openings provided through the existing timber bulkhead.

Alternative 4. This alternative (Figure 5-10) would introduce the tidal, saline Bay water onto the site by creation of a highly braided and meandering system of new channels that connect through the existing series of small, shallow ponds and large ditches. The highly braided system of channels in this alternative would likely create the greatest amount of valuable tidal marsh habitat at the site, but would be the most difficult to construct. This alternative consists of the excavation of a meandering and braided open channel system of approximately 35 feet in width at MLW and 15,900 feet in length, connected to the Bay at the east and in the south through 100-foot wide openings provided through the existing timber bulkhead.


CHANNEL EXCAVATION
OYSTER CREEK - ALTERNATIVE 2
BARNEGAT BAY ECOSYSTEM RESTORATION
FEASIBILITY STUDY
OYSTER CREEK
GRAPHIC SCALE
(IN FEET)
MAP FEATURES (ACRES)
1 = PHRAGMITES MARSH (74.99)
2 = OPEN WATER (12.58)
3 = SHRUB/SCRUB-PHRAGMITES (5.58)
4 = SHRUB/SCRUB-TREES (6.21)
5 = OPEN SAND/BEACH HEATHER (4.93)
6 = SHRUB/SCRUB-BERMS (5.65)
7 = WET MEADOW (1.40)

Figure 5-8.

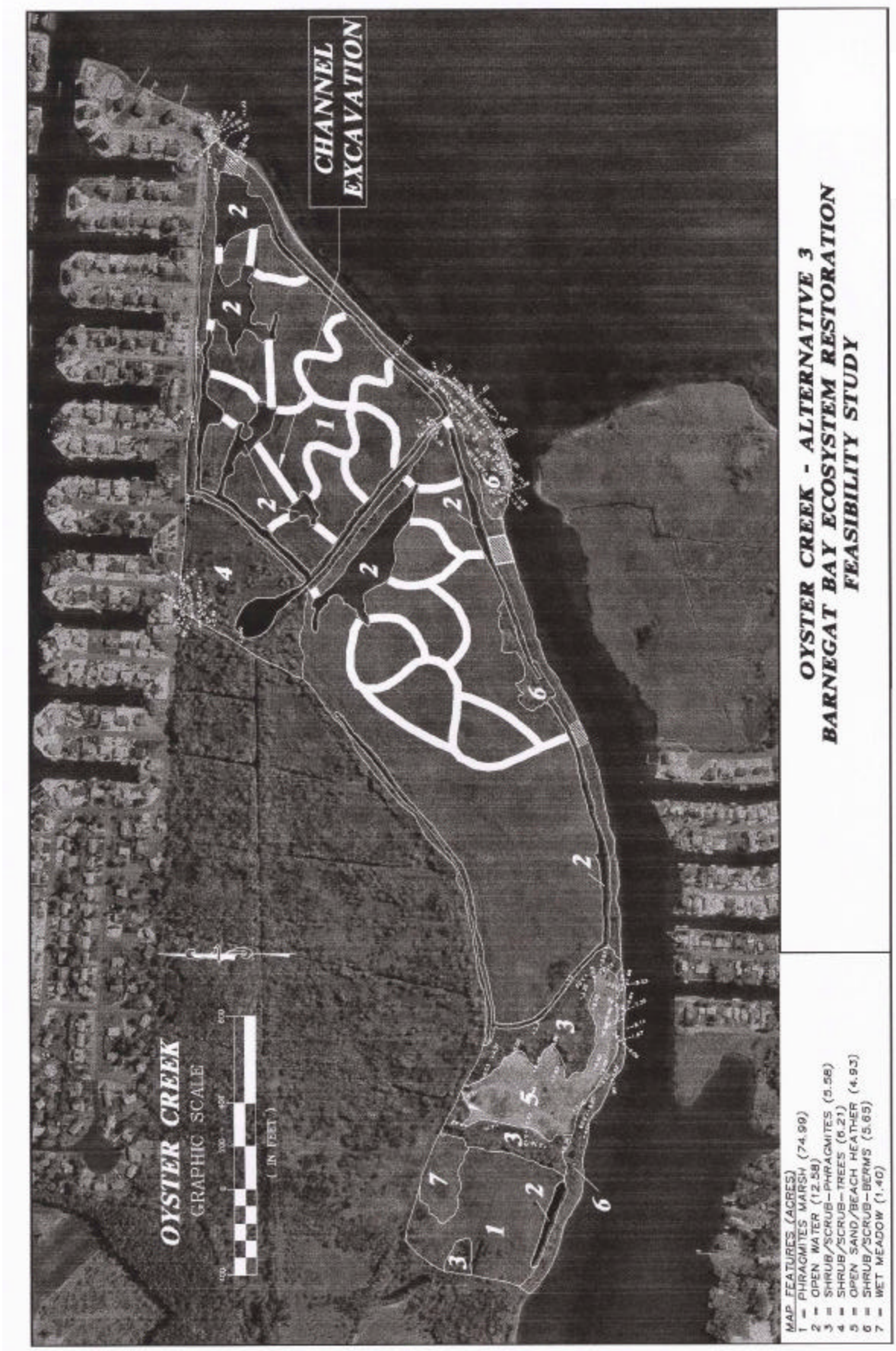

OYSTER CREEK - ALTERNATIVE 3
BARNEGAT BAY ECOSYSTEM RESTORATION
FEASIBILITY STUDY
CHANNEL EXCAVATION
OYSTER CREEK
GRAPHIC SCALE
MAP FEATURES (ACRES)
1 = PHRAGMITES MARSH (74.99)
2 = OPEN WATER (12.58)
3 = SHRUB/SCRUB-PHRAGMITES (5.58)
4 = SHRUB/SCRUB-TREES (6.21)
5 = OPEN SAND/BEACH HEATHER (4.93)
6 = SHRUB/SCRUB-BERMS (5.65)
7 = WET MEADOW (1.40)

Figure 5-9.


CHANNEL EXCAVATION
OYSTER CREEK
GRAPHIC SCALE
(IN FEET)
OYSTER CREEK - ALTERNATIVE 4
BARNEGAT BAY ECOSYSTEM RESTORATION
FEASIBILITY STUDY
MAP FEATURES (ACRES)
1 = PHRAGMITES MARSH (74.99)
2 = OPEN WATER (12.58)
3 = SHRUB/SCRUB-PHRAGMITES (5.58)
4 = SHRUB/SCRUB-TREES (6.21)
5 = OPEN SAND/BEACH HEATHER (4.93)
6 = SHRUB/SCRUB-BERMS (5.65)
7 = WET MEADOW (1.40)

Figure 5-10.

5.4.1.4 Barnegat Lighthouse

The restoration goal of this project is to create new intertidal feeding habitats directly adjacent to an existing breeding population of the Federal threatened piping plover; this would be achieved by creation of a small intertidal pond. The proposed location for the new intertidal pond presents an ideal physical situation for maximizing use by the resident breeding piping plovers; it provides a large amount of surface area for feeding adjacent to the existing nesting sites. The existing plover feeding habitats in the flooded area behind the south jetty and along the ocean-side beach are considered sub-optimal because of the large amount of human disturbance in these areas. The new intertidal feeding pond created by this project would be removed from these human disturbances.

The eight action alternatives differ in the size of the intertidal pond, as well as the number (one or two) and type of connections to tidal water (open channel or piped). For the alternatives with open channels (2A, 3A, 4A, and 5A), the inlets would have a bottom width of 10 feet and side slopes of 4:1, resulting in top widths of 50 to 66 feet, depending on the existing ground elevations at the top of the bank. The entire length of the entrance channel would be lined with erosion control matting (North American Green C-350 or equivalent). Additionally, a golf-cart size, low rail height (60 to 70 feet in length, and 8-foot wide, Steadfast Expressway or equivalent) bridge would be constructed across the open channel inlets for pedestrians and emergency vehicles. The following are the project alternatives for Barnegat Lighthouse.

Alternative 1. No Action. The existing conditions at the site would remain unchanged.

Alternatives 2A and 2B. This alternative consists of the excavation of a pond with a surface area of approximately 5 acres measured at MHW with access to tidal water landward of the Barnegat Inlet south jetty by means of a single inlet formed by an open channel, Alternative 2A (Figure 5-11), or a culvert system, Alternative 2B (Figure 5-12). These openings would provide means of tidal water access to the pond through the depressed area running along the south side of the Barnegat Inlet south jetty, which is periodically inundated by tidal water that penetrates through the stone jetty structure as well as through the opening at the eastern end of the jetty. Water will flow to the pond on every tide cycle. The pond will be flooded most of the time.

Alternatives 3A and 3B. This alternative consists of the excavation of a pond with a surface area of approximately 2.0 acres measured at MHW with access to tidal water landward of the Barnegat Inlet south jetty by means of a single inlet formed by an open channel, Alternative 3A (Figure 5-13) or a culvert system, Alternative 3B (Figure 5-14). These openings would provide means of tidal water access to the pond through the depressed area running along the south side of the Barnegat Inlet south jetty, which is periodically inundated by tidal water that penetrates through the stone jetty structure as well as through the opening at the east end of the jetty. Water will flow to the pond on every tide cycle. The pond will be flooded most of the time.

Alternatives 4A and 4B. This alternative consists of the excavation of a pond with a surface area of approximately 5 acres measured at MHW with access to tidal water landward of the Barnegat Inlet south jetty by means of two inlets formed by two open channels, Alternative 4A

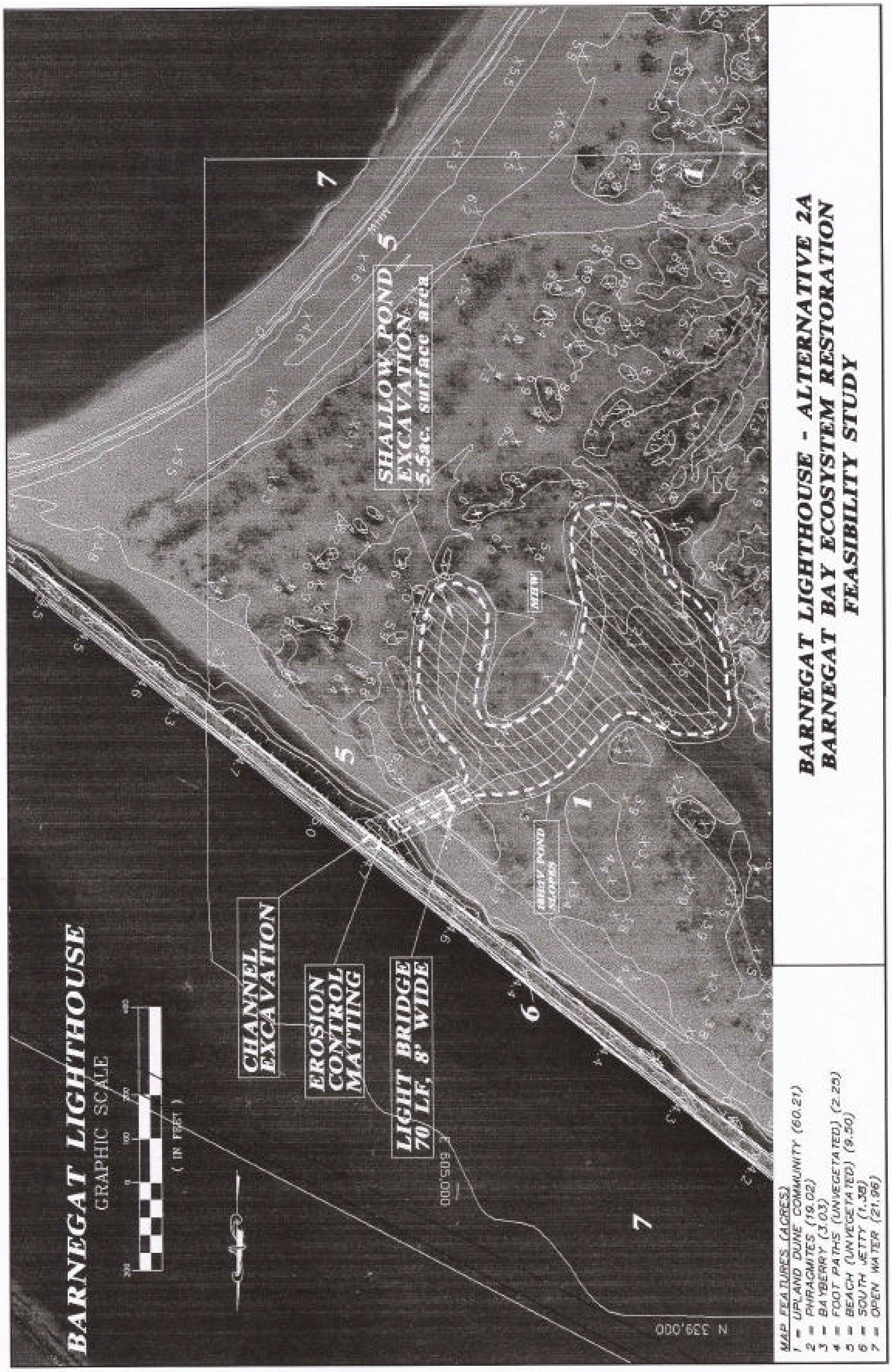

BARNEGAT LIGHTHOUSE
GRAPHIC SCALE
(IN FEET)
CHANNEL EXCAVATION
EROSION CONTROL MATTING
LIGHT BRIDGE 70' LF, 8' WIDE
SHALLOW POND EXCAVATION
5.5ac. surface area
N 339,000
605,000
BARNEGAT LIGHTHOUSE - ALTERNATIVE 2A
BARNEGAT BAY ECOSYSTEM RESTORATION
FEASIBILITY STUDY
MAP FEATURES (ACRES)
1 = UPLAND DUNE COMMUNITY (60.21)
2 = PHRAGMITES (19.02)
3 = BAYBERRY (3.03)
4 = FOOT PATHS (UNVEGETATED) (2.25)
5 = BEACH (UNVEGETATED) (9.50)
6 = SOUTH JETTY (1.38)
7 = OPEN WATER (21.96)

Figure 5-11.

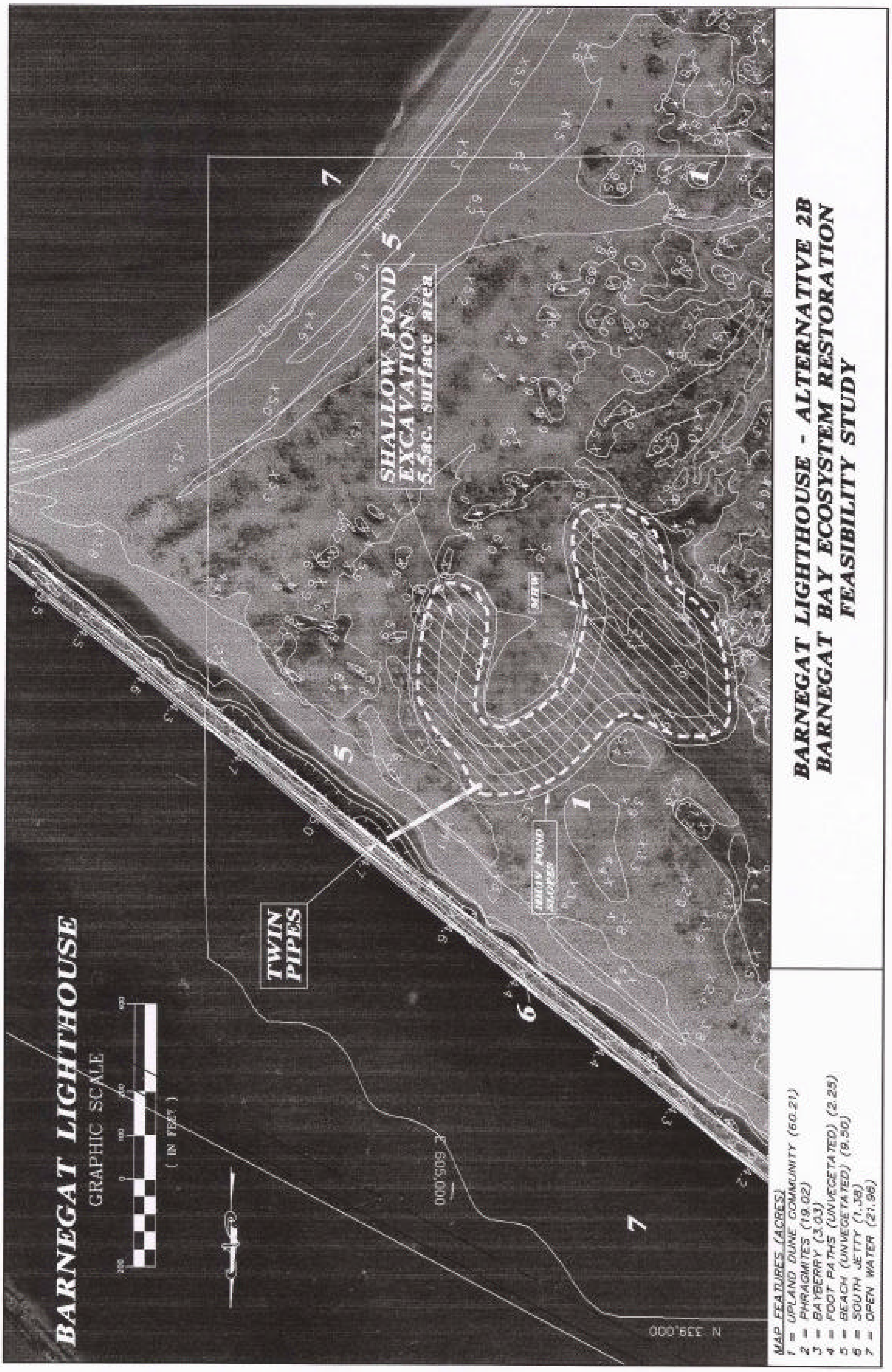

BARNEGAT LIGHTHOUSE
GRAPHIC SCALE
(IN FEET)
TWIN PIPES
SHALLOW POND EXCAVATION
5.5ac. surface area
BARNEGAT LIGHTHOUSE - ALTERNATIVE 2B
BARNEGAT BAY ECOSYSTEM RESTORATION
FEASIBILITY STUDY
MAP FEATURES (ACRES)
1 = UPLAND DUNE COMMUNITY (60.21)
2 = PHRAGMITES (19.02)
3 = BAYBERRY (3.03)
4 = FOOT PATHS (UNVEGETATED) (2.25)
5 = BEACH (UNVEGETATED) (9.50)
6 = SOUTH JETTY (1.38)
7 = OPEN WATER (21.96)
N 339,000
E 605,000

Figure 5-12.

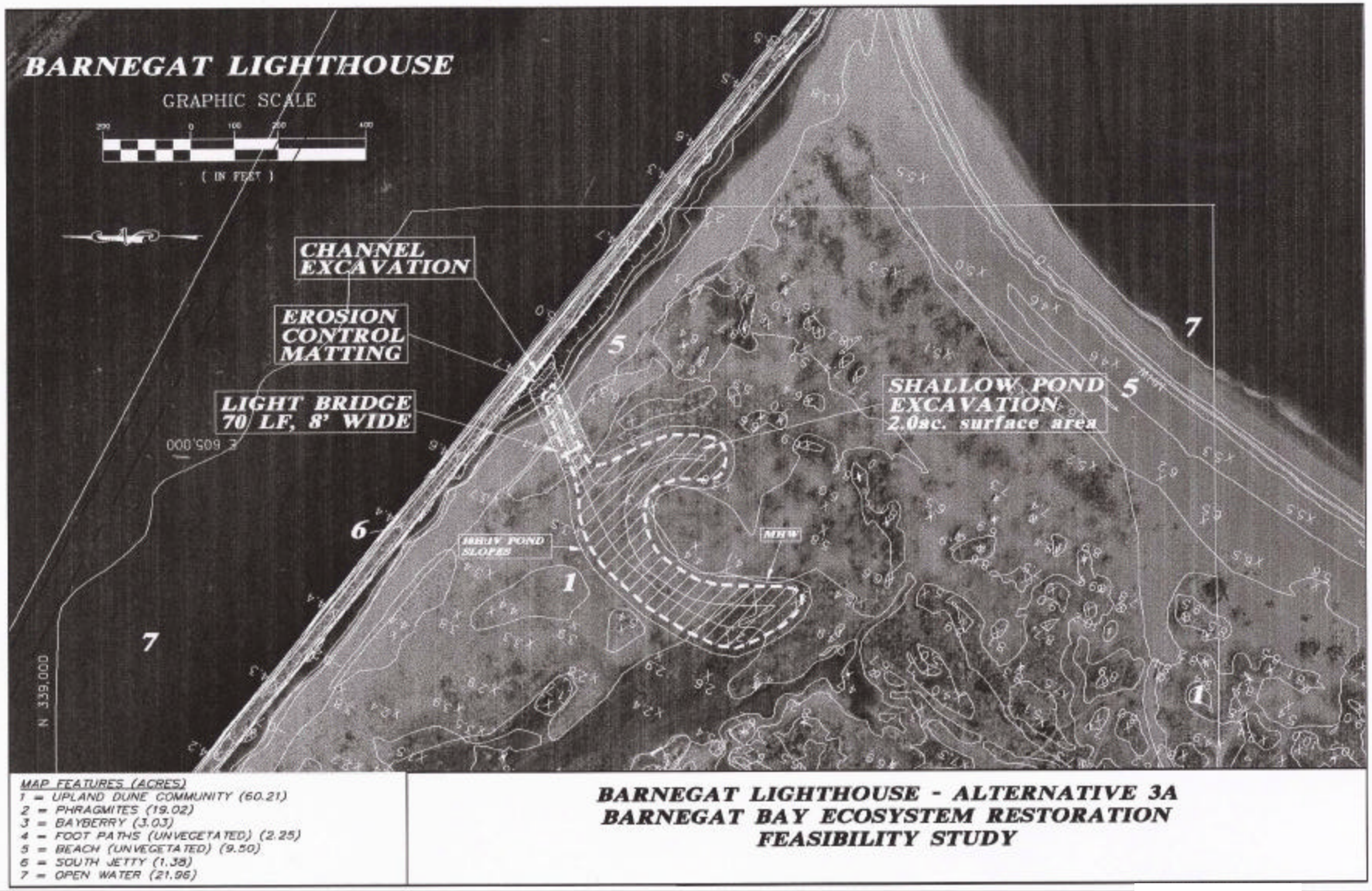

BARNEGAT LIGHTHOUSE
GRAPHIC SCALE
(IN FEET)
CHANNEL EXCAVATION
EROSION CONTROL MATTING
LIGHT BRIDGE 70 LF, 8' WIDE
SHALLOW POND EXCAVATION 2.0ac. surface area
MBW
MBW POND SLOPES
MAP FEATURES (ACRES)
1 = UPLAND DUNE COMMUNITY (60.21)
2 = PHRAGMITES (19.02)
3 = BAYBERRY (3.03)
4 = FOOT PATHS (UNVEGETATED) (2.25)
5 = BEACH (UNVEGETATED) (9.50)
6 = SOUTH JETTY (1.38)
7 = OPEN WATER (21.96)
BARNEGAT LIGHTHOUSE - ALTERNATIVE 3A
BARNEGAT BAY ECOSYSTEM RESTORATION
FEASIBILITY STUDY

Figure 5-13.

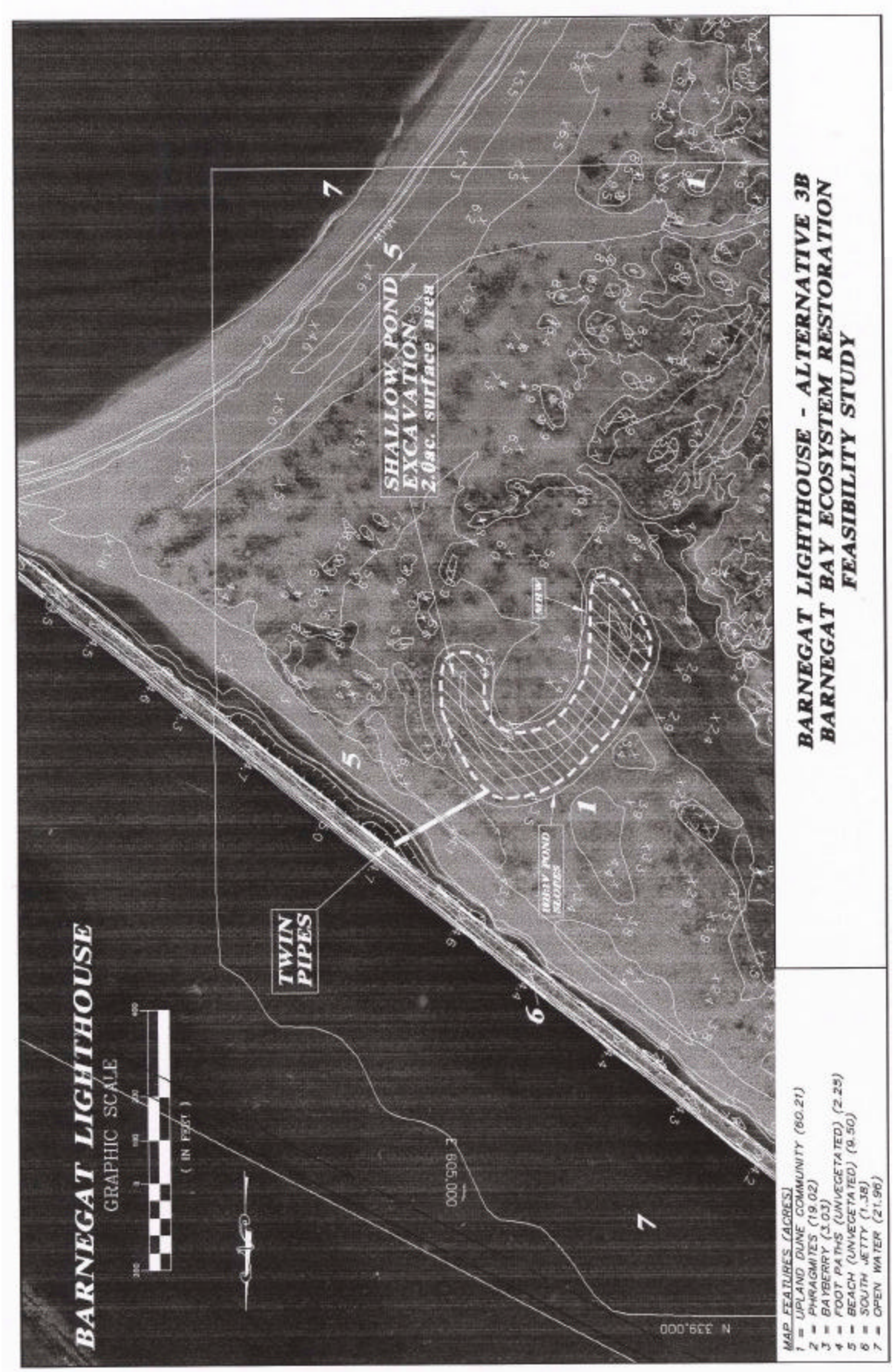

BARNEGAT LIGHTHOUSE
GRAPHIC SCALE
(IN FEET)
TWIN PIPES
SHALLOW POND EXCAVATION 2.0ac. surface area
BARNEGAT LIGHTHOUSE - ALTERNATIVE 3B
BARNEGAT BAY ECOSYSTEM RESTORATION
FEASIBILITY STUDY
MAP FEATURES (ACRES)
1 = UPLAND DUNE COMMUNITY (80.21)
2 = PHRAGMITES (19.02)
3 = BAYBERRY (3.03)
4 = FOOT PATHS (UNVEGETATED) (2.25)
5 = BEACH (UNVEGETATED) (9.50)
6 = SOUTH JETTY (1.38)
7 = OPEN WATER (21.96)
N 339,000
E 606,000

Figure 5-14.

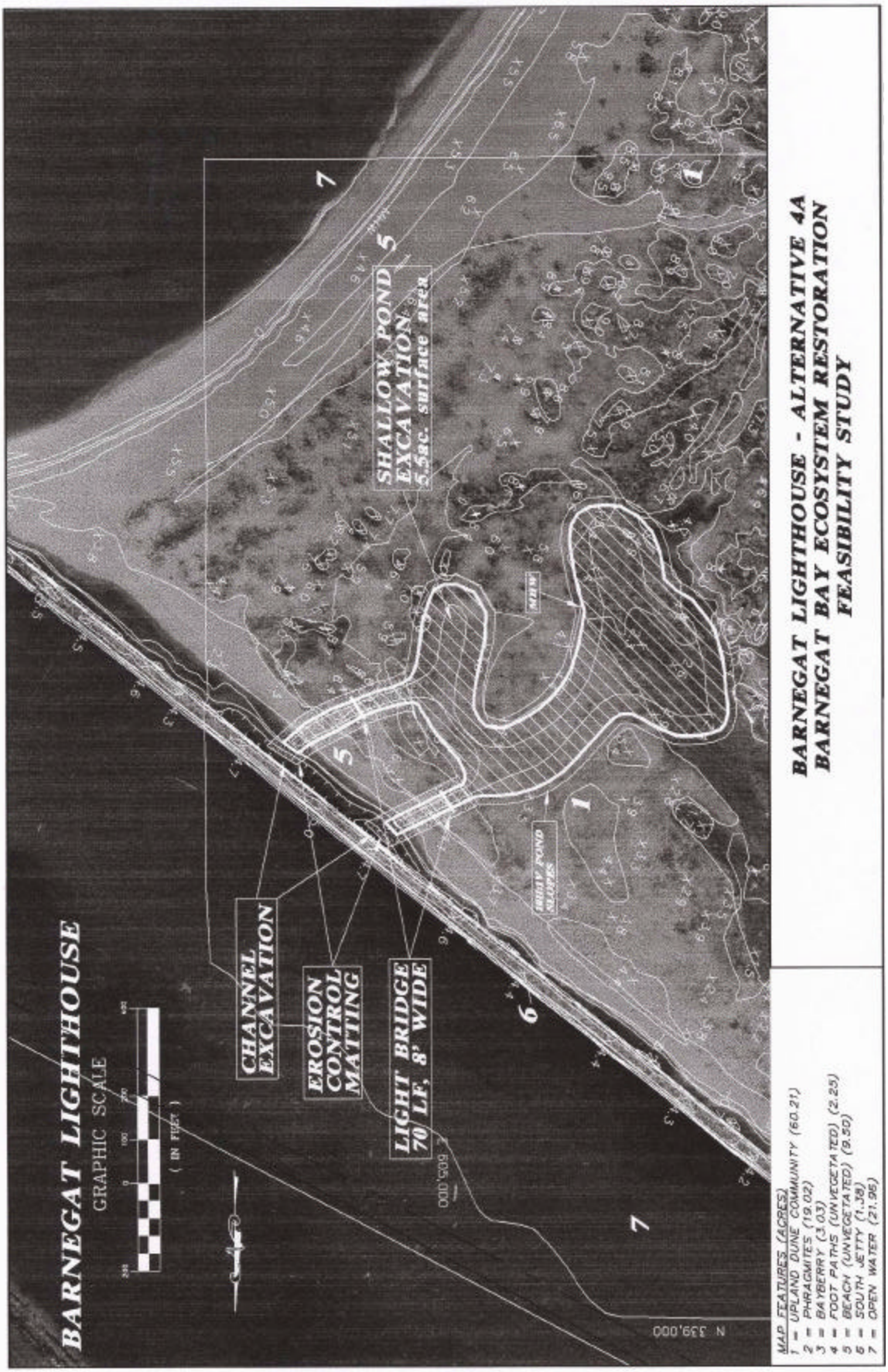

BARNEGAT LIGHTHOUSE
GRAPHIC SCALE
(IN FEET)
CHANNEL EXCAVATION
EROSION CONTROL MATTING
LIGHT BRIDGE 70 LF, 8' WIDE
SHALLOW POND EXCAVATION 5.5ac. surface area
MHW
SHELLY POND SHORES
N 339,000
E 605,000
MAP FEATURES (ACRES)
1 = UPLAND DUNE COMMUNITY (60.21)
2 = PHRAGMITES (19.02)
3 = BAYBERRY (3.03)
4 = FOOT PATHS (UNVEGETATED) (2.25)
5 = BEACH (UNVEGETATED) (9.50)
6 = SOUTH JETTY (1.38)
7 = OPEN WATER (21.96)
BARNEGAT LIGHTHOUSE - ALTERNATIVE 4A
BARNEGAT BAY ECOSYSTEM RESTORATION
FEASIBILITY STUDY

Figure 5-15.


BARNEGAT LIGHTHOUSE - ALTERNATIVE 4B
BARNEGAT BAY ECOSYSTEM RESTORATION
FEASIBILITY STUDY
BARNEGAT LIGHTHOUSE
GRAPHIC SCALE
(IN FEET)
SHALLOW POND EXCAVATION 5.5ac. surface area
TWIN PIPES
MARSH POND SLOPES
MHW
MAP FEATURES (ACRES)
1 = UPLAND DUNE COMMUNITY (60.21)
2 = PHRAGMITES (19.02)
3 = BAYBERRY (3.03)
4 = FOOT PATHS (UNVEGETATED) (2.25)
5 = BEACH (UNVEGETATED) (9.50)
6 = SOUTH JETTY (1.38)
7 = OPEN WATER (21.96)
N 339,000
E 605,000

Figure 5-16.


BARNEGAT LIGHTHOUSE
GRAPHIC SCALE
(IN FEET)
CHANNEL EXCAVATION
EROSION CONTROL MATTING
LIGHT BRIDGE 70 LF, 8' WIDE
SHALLOW POND EXCAVATION 2.0ac. surface area
E 605,000
N 339,000
MAP FEATURES (ACRES)
1 = UPLAND DUNE COMMUNITY (60.21)
2 = PHRAGMITES (19.02)
3 = BAYBERRY (3.03)
4 = FOOT PATHS (UNVEGETATED) (2.25)
5 = BEACH (UNVEGETATED) (9.50)
6 = SOUTH JETTY (1.38)
7 = OPEN WATER (21.96)
BARNEGAT LIGHTHOUSE - ALTERNATIVE 5A
BARNEGAT BAY ECOSYSTEM RESTORATION
FEASIBILITY STUDY

Figure 5-17.

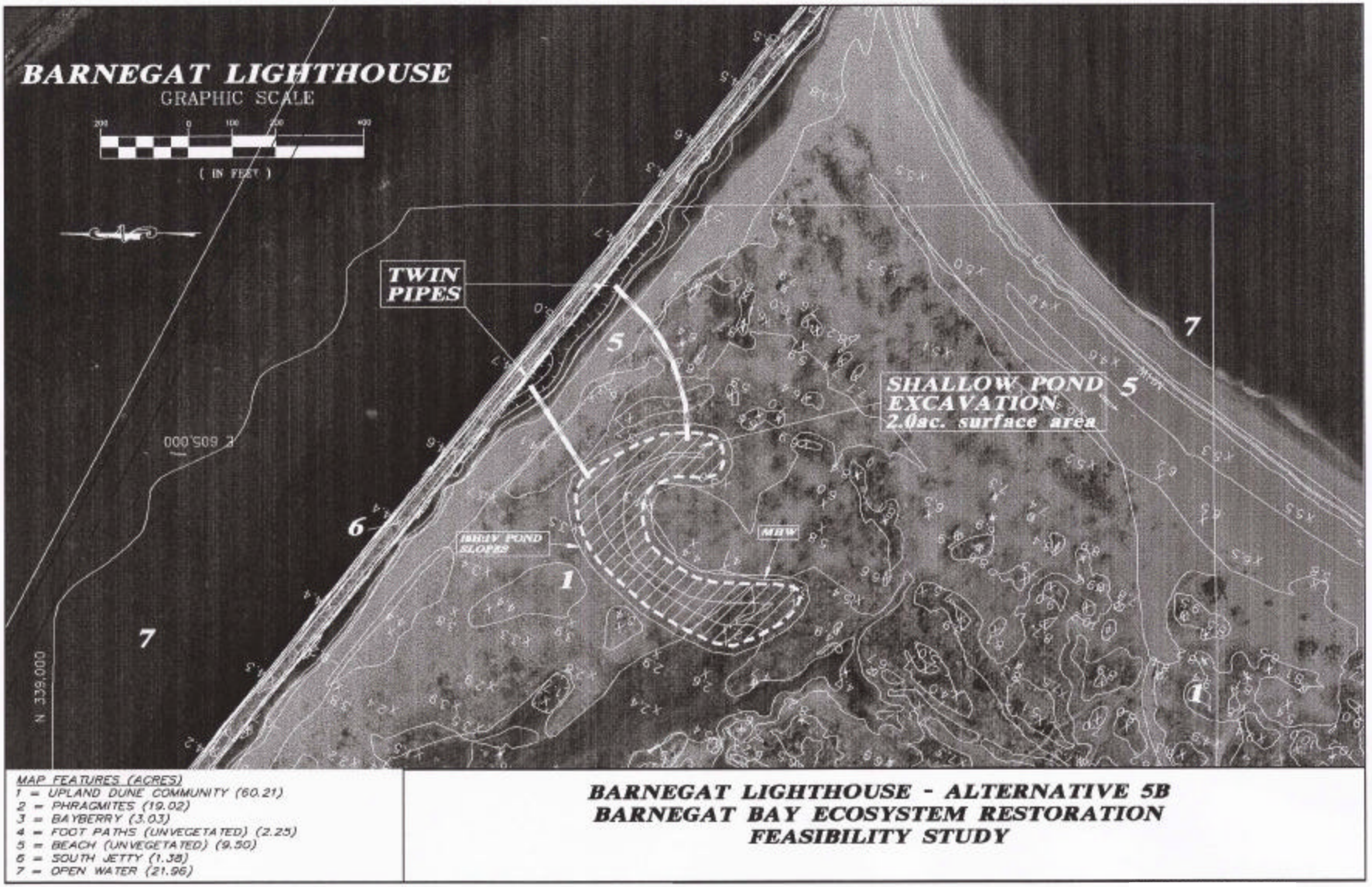

BARNEGAT LIGHTHOUSE
GRAPHIC SCALE
200 0 100 200 400
(IN FEET)
TWIN PIPES
SHALLOW POND EXCAVATION
2.0ac. surface area
SHALLOW POND SLOPES
MHW
5
7
6
1
N 339,000
MAP FEATURES (ACRES)
1 = UPLAND DUNE COMMUNITY (60.21)
2 = PHRAGMITES (19.02)
3 = BAYBERRY (3.03)
4 = FOOT PATHS (UNVEGETATED) (2.25)
5 = BEACH (UNVEGETATED) (9.50)
6 = SOUTH JETTY (1.38)
7 = OPEN WATER (21.96)
BARNEGAT LIGHTHOUSE - ALTERNATIVE 5B
BARNEGAT BAY ECOSYSTEM RESTORATION
FEASIBILITY STUDY

Figure 5-18.

(Figure 5-15), or two culvert systems, Alternative 4B (Figure 5-16). These openings would provide means of tidal water access to the pond through the depressed area running along the south side of the Barnegat Inlet south jetty, which is periodically inundated by tidal water that penetrates through the stone jetty structure as well as through the opening at the east end of the jetty. Water will flow to the pond on every tide cycle. The pond will be flooded most of the time.

Alternatives 5A and 5B. This alternative consists of the excavation of a pond with a surface area of approximately 2.0 acres measured at MHW, and two open channels, Alternative 5A (Figure 5-17), or two culvert systems, Alternative 5B (Figure 5-18). These culverts would provide means of tidal water access to the pond through the depressed area running along the south side of Barnegat Inlet south jetty, which is periodically inundated by tidal water that penetrates through the stone jetty structure as well as through the opening at the east end of the jetty. Water will flow to the pond on every tide cycle. The pond will be flooded most of the time.

5.4.1.5 Stafford Forge

The restoration goals for this project are to allow for passage of anadromous and catadromous fishes (river herring and American eel, respectively) on Westecunk Creek at and/or above the Stafford Forge site, and to convert several large off-stream open water ponds to more ecologically valuable vegetated emergent wetlands with interspersed small areas of open water. Fish passage on Westecunk Creek through the Stafford Forge site has likely been blocked for at least 60 years, when water control structures were first installed to grow cranberries. There are currently three fish blockages at the Stafford Forge site (upstream, midstream, downstream). The project action alternatives provide for a combination of opening fish passage to pond habitats and/or stream habitats above the existing blockages. Based on recent map measurements, a maximum of approximately 10.2 combined stream miles could be made available to fish on Westecunk Creek above Stafford Forge, depending on the project alternative. According to NJDEP Division of Fish and Wildlife, and from observations made on the site during extensive field studies, the large, fairly deep off-stream ponds on the site do not currently support a high quality fishery. Conversion of these open water areas to emergent wetlands with interspersed open water would also provide much greater overall habitat value to wildlife such as black duck and other dabbling waterfowl, and possibly could improve the fishery. The average water depth in these ponds would be about 18 inches; it is possible that freshwater SAV species and/or emergent plant species could become established in some areas of the ponds. This mixture of native wetland species would maximize feeding opportunities for many species of dabbling waterfowl.

The alternatives provide a wide range of options for creating fish passage and improving the quality of the ponds. They differ in the number of areas fish would gain access to and whether the ponds would be made shallower to mimic existing high quality ponds on the site. Many technical options for providing fish passage have been reviewed, but only the best options are included in the alternatives as the others provide no significant restoration or cost benefits. The following are the proposed alternatives for Stafford Forge.

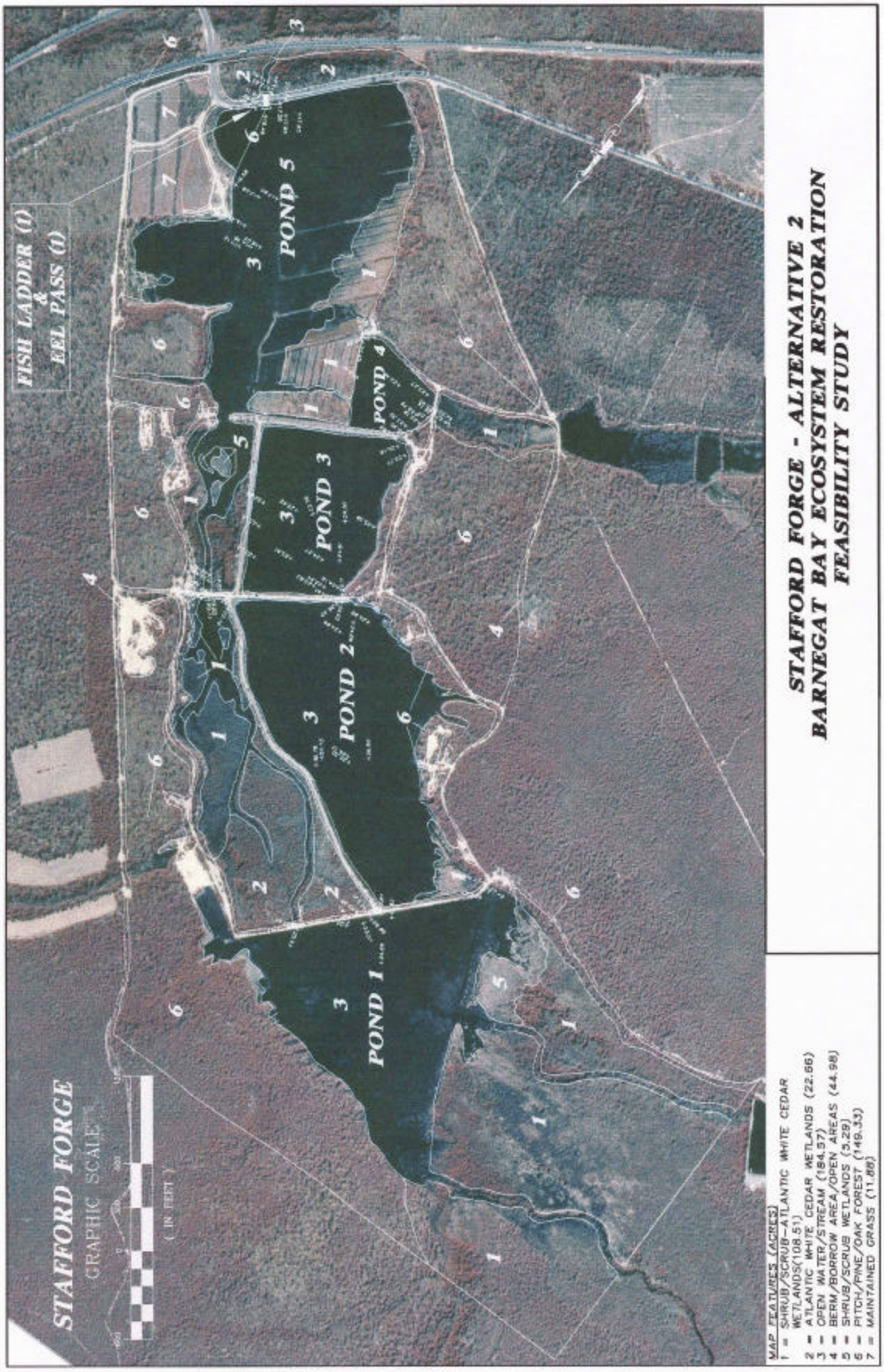

STAFFORD FORGE - ALTERNATIVE 2
BARNEGAT BAY ECOSYSTEM RESTORATION
FEASIBILITY STUDY
FISH LADDER (1)
&
EEL PASS (1)
POND 1
POND 2
POND 3
POND 4
POND 5
STAFFORD FORGE
GRAPHIC SCALE
(IN FEET)
MAP FEATURES (ACRES)
1 = SHRUB/SCRUB-ATLANTIC WHITE CEDAR WETLANDS(108.51)
2 = ATLANTIC WHITE CEDAR WETLANDS (22.66)
3 = OPEN WATER/STREAM (184.57)
4 = BERM/BORROW AREA/OPEN AREAS (44.98)
5 = SHRUB/SCRUB WETLANDS (3.29)
6 = PITCH/PINE/OAK FOREST (149.33)
7 = MAINTAINED GRASS (11.88)

Figure 5-19.

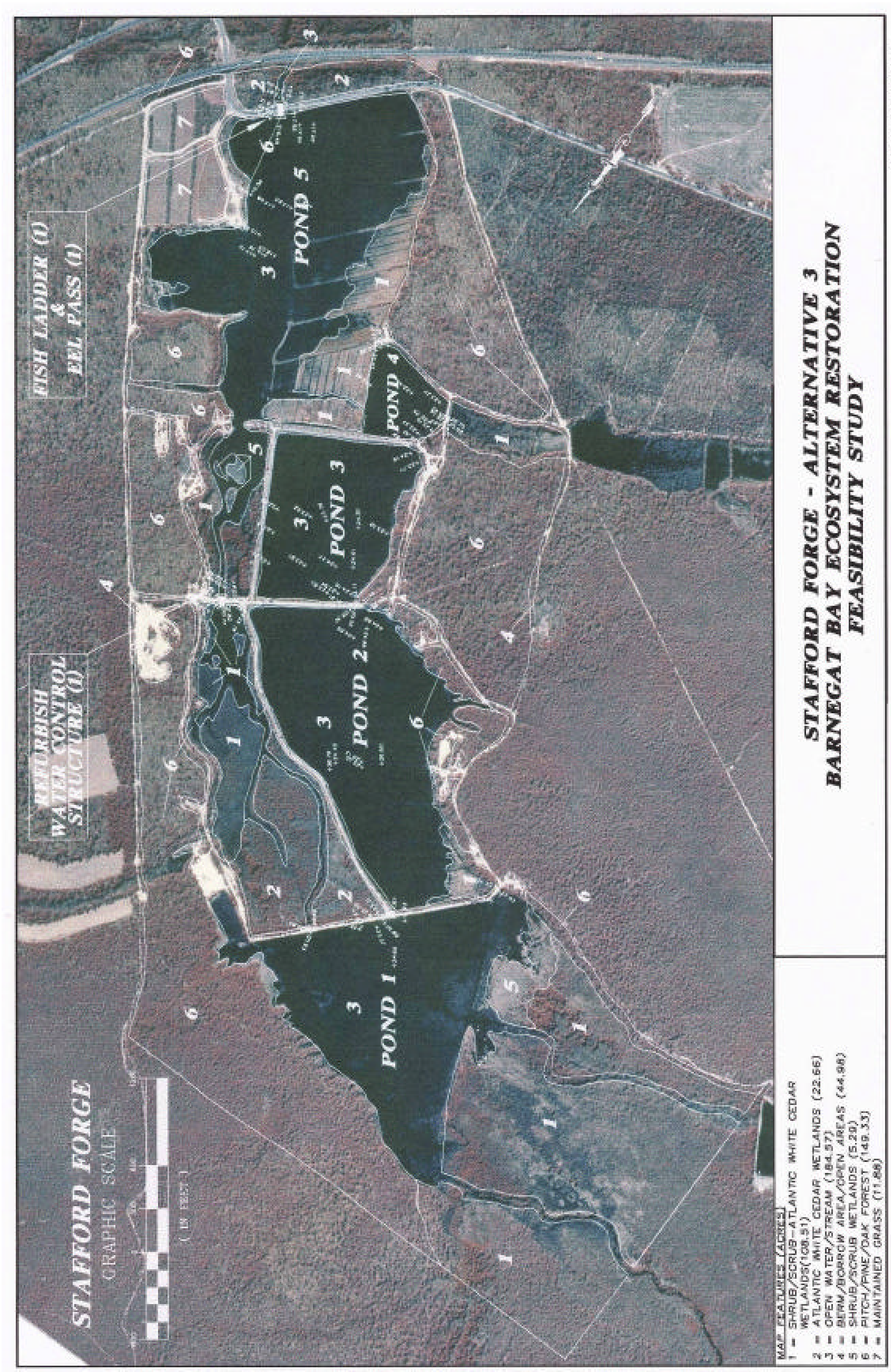

STAFFORD FORGE - ALTERNATIVE 3
BARNEGAT BAY ECOSYSTEM RESTORATION
FEASIBILITY STUDY
STAFFORD FORGE
GRAPHIC SCALE
(IN FEET)
FISH LADDER (1)
&
EEL PASS (1)
REFURBISH
WATER CONTROL
STRUCTURE (1)
POND 1
POND 2
POND 3
POND 4
POND 5
MAP FEATURES (ACRES)
1 = SHRUB/SCRUB-ATLANTIC WHITE CEDAR WETLANDS(108.51)
2 = ATLANTIC WHITE CEDAR WETLANDS (22.66)
3 = OPEN WATER/STREAM (184.57)
4 = BERM/BORROW AREA/OPEN AREAS (44.98)
5 = SHRUB/SCRUB WETLANDS (5.29)
6 = PITCH/PINE/OAK FOREST (149.33)
7 = MAINTAINED GRASS (11.88)

Figure 5-20.

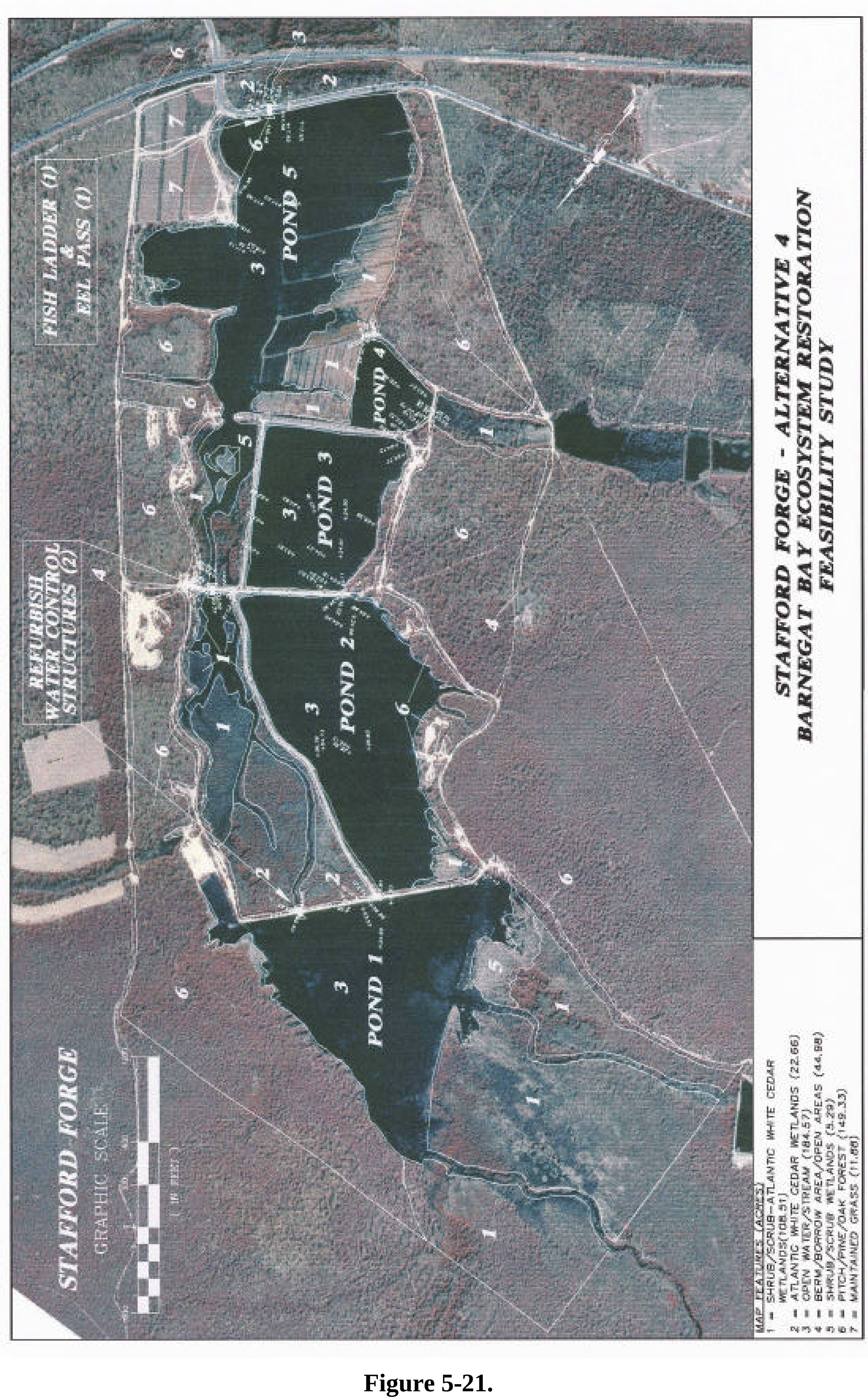

STAFFORD FORGE - ALTERNATIVE 4
BARNEGAT BAY ECOSYSTEM RESTORATION
FEASIBILITY STUDY
STAFFORD FORGE
GRAPHIC SCALE
FISH LADDER (1) & EEL PASS (1)
REFURBISH WATER CONTROL STRUCTURES (2)
POND 1
POND 2
POND 3
POND 4
POND 5
MAP FEATURES (ACRES)
1 = SHRUB/SCRUB-ATLANTIC WHITE CEDAR WETLANDS (108.51)
2 = ATLANTIC WHITE CEDAR WETLANDS (22.66)
3 = OPEN WATER/STREAM (184.57)
4 = BERM/BORROW AREA/OPEN AREAS (44.98)
5 = SHRUB/SCRUB WETLANDS (5.29)
6 = PITCH/PINE/OAK FOREST (149.33)
7 = MAINTAINED GRASS (11.88)

Figure 5-21.

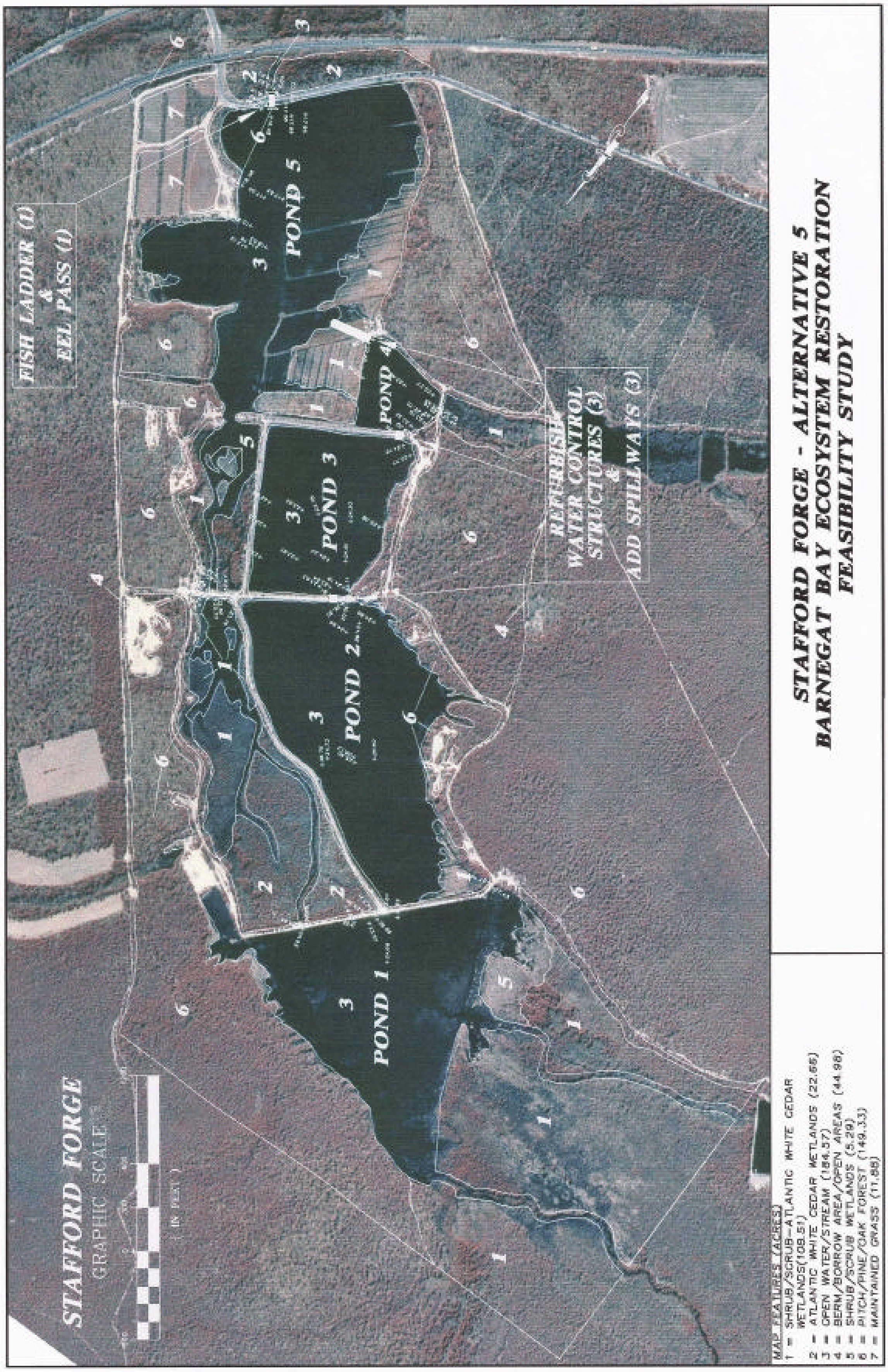

STAFFORD FORGE - ALTERNATIVE 5
BARNEGAT BAY ECOSYSTEM RESTORATION
FEASIBILITY STUDY
FISH LADDER (1) & EEL PASS (1)
REFURBISH WATER CONTROL STRUCTURES (3) & ADD SPILLWAYS (3)
POND 1
POND 2
POND 3
POND 4
POND 5
STAFFORD FORGE
GRAPHIC SCALE
(IN FEET)
MAP FEATURES (ACRES)
1 = SHRUB/SCRUB-ATLANTIC WHITE CEDAR WETLANDS(109.51)
2 = ATLANTIC WHITE CEDAR WETLANDS (22.65)
3 = OPEN WATER/STREAM (184.57)
4 = BERM/BORROW AREA/OPEN AREAS (44.98)
5 = SHRUB/SCRUB WETLANDS (5.29)
6 = PITCH/PINE/OAK FOREST (149.33)
7 = MAINTAINED GRASS (11.88)

Figure 5-22.

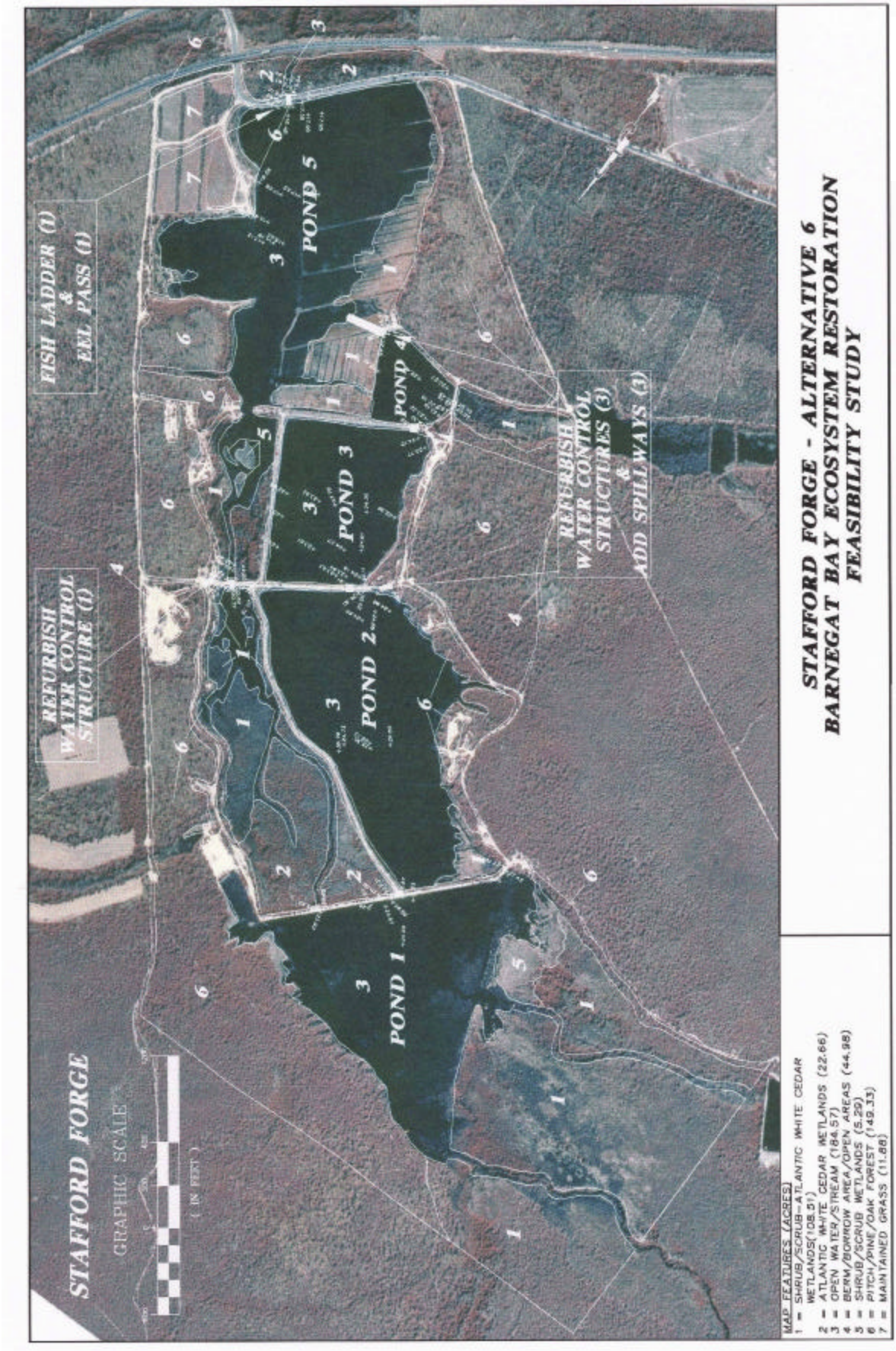

STAFFORD FORGE
GRAPHIC SCALE
(IN FEET)
REFURBISH WATER CONTROL STRUCTURE (1)
FISH LADDER (1) & EEL PASS (1)
REFURBISH WATER CONTROL STRUCTURES (3) & ADD SPILLWAYS (3)
POND 1
POND 2
POND 3
POND 4
POND 5
MAP FEATURES (ACRES)
1 = SHRUB/SCRUB-ATLANTIC WHITE CEDAR WETLANDS(108.51)
2 = ATLANTIC WHITE CEDAR WETLANDS (22.66)
3 = OPEN WATER/STREAM (184.57)
4 = BERM/BORROW AREA/OPEN AREAS (44.98)
5 = SHRUB/SCRUB WETLANDS (5.29)
6 = PITCH/PINE/OAK FOREST (149.33)
7 = MAINTAINED GRASS (11.88)
STAFFORD FORGE - ALTERNATIVE 6
BARNEGAT BAY ECOSYSTEM RESTORATION
FEASIBILITY STUDY

Figure 5-23.

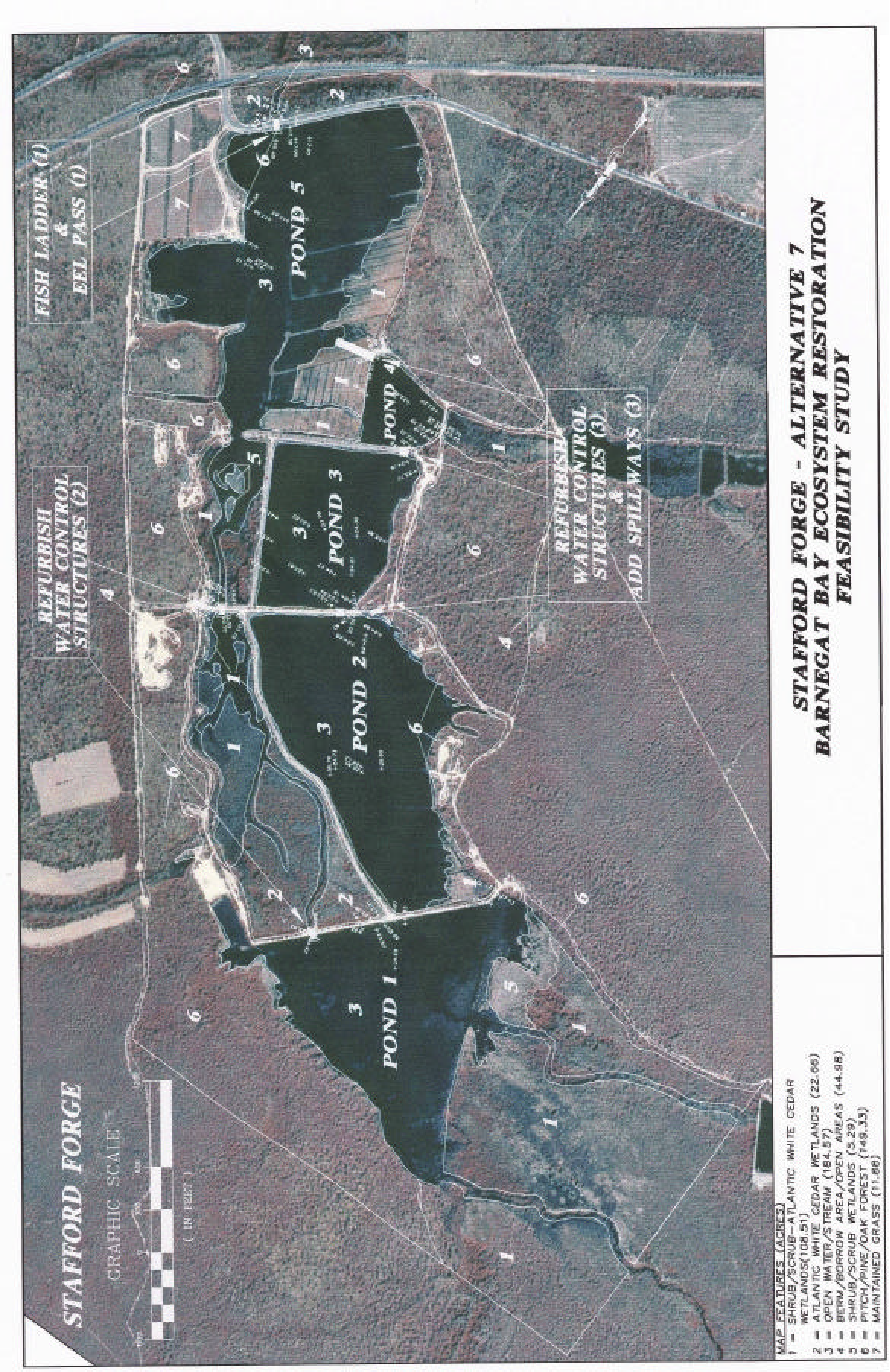

STAFFORD FORGE - ALTERNATIVE 7
BARNEGAT BAY ECOSYSTEM RESTORATION
FEASIBILITY STUDY
FISH LADDER (1) & EEL PASS (1)
REFURBISH WATER CONTROL STRUCTURES (2)
REFURBISH WATER CONTROL STRUCTURES (3) & ADD SPILLWAYS (3)
POND 1
POND 2
POND 3
POND 4
POND 5
STAFFORD FORGE
GRAPHIC SCALE
(IN FEET)
MAP FEATURES (ACRES)
1 = SHRUB/SCRUB-ATLANTIC WHITE CEDAR WETLANDS(108.51)
2 = ATLANTIC WHITE CEDAR WETLANDS (22.66)
3 = OPEN WATER/STREAM (184.57)
4 = BERM/BORROW AREA/OPEN AREAS (44.98)
5 = SHRUB/SCRUB WETLANDS (5.29)
6 = PITCH/PINE/OAK FOREST (149.33)
7 = MAINTAINED GRASS (11.88)

Figure 5-24.

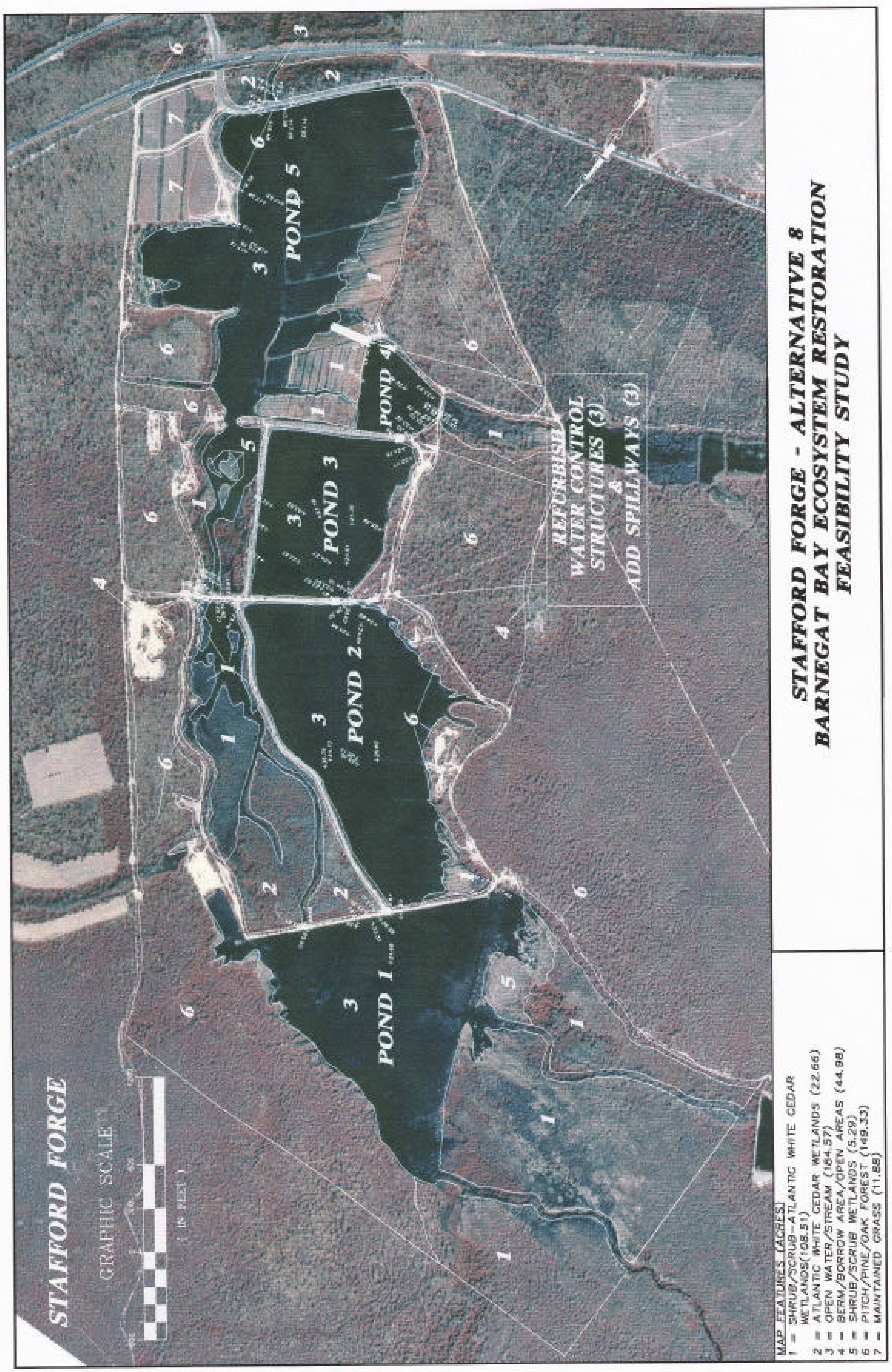

STAFFORD FORGE
GRAPHIC SCALE
(IN FEET)
POND 1
POND 2
POND 3
POND 4
POND 5
REFURBISH WATER CONTROL STRUCTURES (3) & ADD SPILLWAYS (3)
STAFFORD FORGE - ALTERNATIVE 8
BARNEGAT BAY ECOSYSTEM RESTORATION
FEASIBILITY STUDY
MAP FEATURES (ACRES)
1 = SHRUB/SCRUB-ATLANTIC WHITE CEDAR WETLANDS(108.51)
2 = ATLANTIC WHITE CEDAR WETLANDS (22.66)
3 = OPEN WATER/STREAM (164.57)
4 = BERM/BORROW AREA/OPEN AREAS (44.98)
5 = SHRUB/SCRUB WETLANDS (5.29)
6 = PITCH/PINE/OAK FOREST (149.33)
7 = MAINTAINED GRASS (11.88)

Figure 5-25.

Alternative 1. No Action. The existing conditions at the site would remain unchanged.

Alternative 2. This alternative (Figure 5-19) consists of adding a fish passage and an eel pass device to the existing water control structure at Pond 5. A number of options were evaluated for these devices. The details of these evaluations are included in Appendix E, Section 6, Project Design. The preferred options were the wooden denil with downstream weir for fish passage, and the lined pipe American eel passage device. These devices will provide fish and eel access to new shallow pond and stream bed.

Alternative 3. In addition to Alternative 2, this alternative consists of refurbishing the existing riser-pipe culvert system to accommodate fish passage in the stream channel of Westecunk Creek across the berm extending to Pond 2 (Figure 5-20). This will provide fish access to an additional new stream and shallow water area above the water control structure at Pond 5.

Alternative 4. In addition to Alternative 3, this alternative consists of refurbishing the existing riser-pipe culvert system to accommodate fish passage through the berm defining the downstream perimeter of Pond 1 (Figure 5-21). This will provide fish access to new shallow pond and new stream area, above the water control structure at Pond 5, plus the tributaries throughout the watershed of Westecunk Creek upstream of Pond 1, involving several miles of stream.

Alternative 5. In addition to the components of Alternative 2, this alternative consists of refurbishing existing water control structures and installing three water control structures at Ponds 2, 3 and 4 to lower the water levels to an average of 18 inches (Figure 5-22). Water levels in Ponds 1 and 5 will not be affected by this project.

Alternative 6. In addition to Alternative 3, this alternative consists of refurbishing existing water control structures and installing three water control structures at Ponds 2, 3 and 4 to lower the water levels to an average of 18 inches (Figure 5-23). Water levels in Ponds 1 and 5 will not be affected by this project.

Alternative 7. In addition to Alternative 4, this alternative consists of refurbishing existing water control structures and installing three water control structures at Ponds 2, 3 and 4 to lower the water levels to an average of 18 inches (Figure 5-24). Water levels in Ponds 1 and 5 will not be affected by this project.

Alternative 8. This alternative consists of only refurbishing existing water control structures and installing three water control structures at Ponds 2, 3 and 4 to lower the water levels to an average of 18 inches (Figure 5-25). Water levels in Ponds 1 and 5 will not be affected by this project. None of the fish passage component encompassed by Alternatives 2, 3, or 4 are included as part of this alternative.

5.4.1.6 Flat Island

The restoration goals of this project are to convert the large existing areas of monotypic phragmites marsh (poor existing habitat for wildlife) into significant new tidal (spartina) marsh

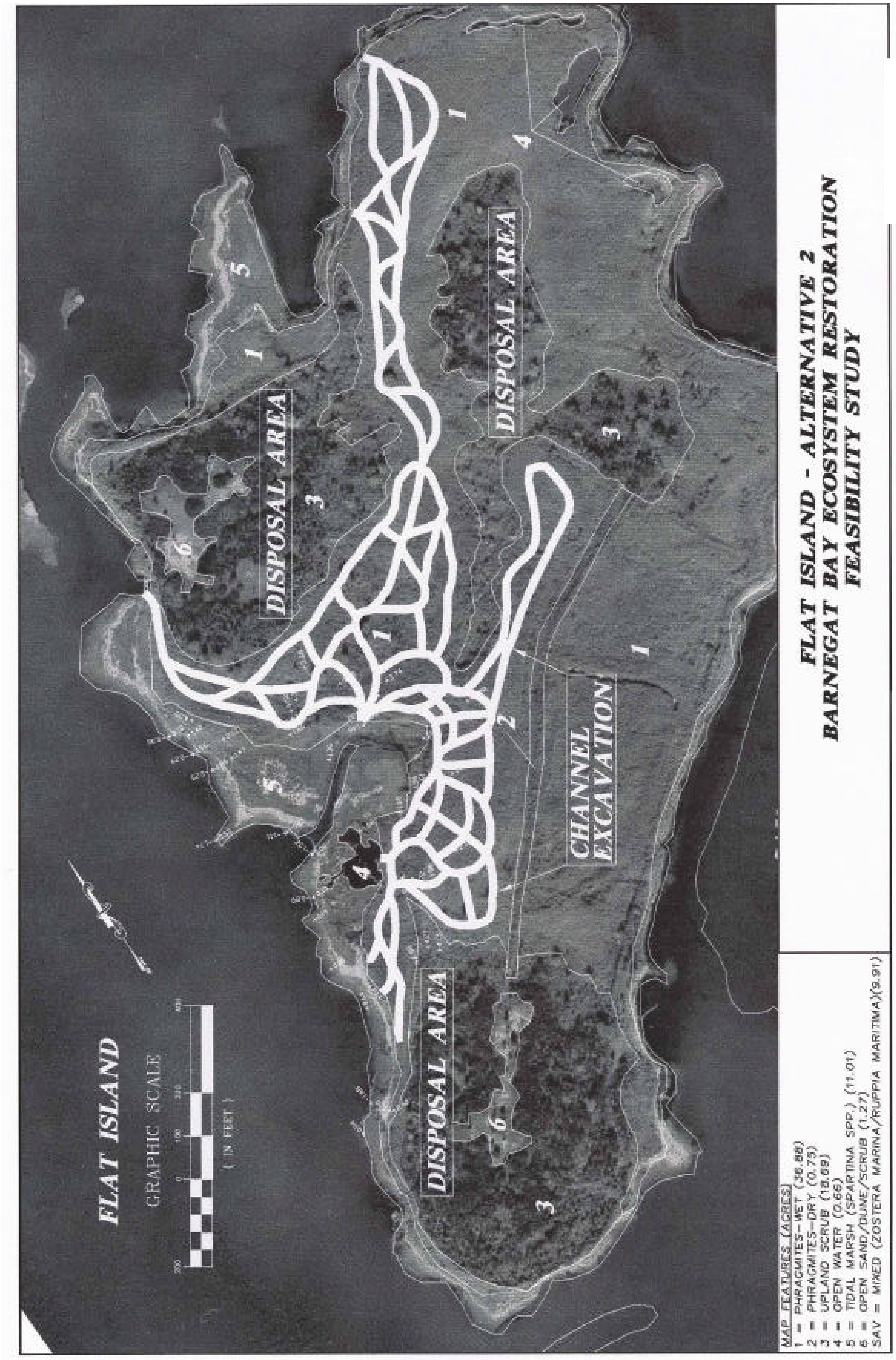

FLAT ISLAND - ALTERNATIVE 2
BARNEGAT BAY ECOSYSTEM RESTORATION
FEASIBILITY STUDY
DISPOSAL AREA
DISPOSAL AREA
DISPOSAL AREA
CHANNEL EXCAVATION
FLAT ISLAND
GRAPHIC SCALE
(IN FEET)
MAP FEATURES (ACRES)
1 = PHRAGMITES-WET (36.88)
2 = PHRAGMITES-DRY (0.75)
3 = UPLAND SCRUB (18.69)
4 = OPEN WATER (0.66)
5 = TIDAL MARSH (SPARTINA SPP.) (11.01)
6 = OPEN SAND/DUNE/SCRUB (1.27)
SAV = MIXED (ZOSTERA MARINA/RUPPIA MARITIMA)(9.91)

Figure 5-26.

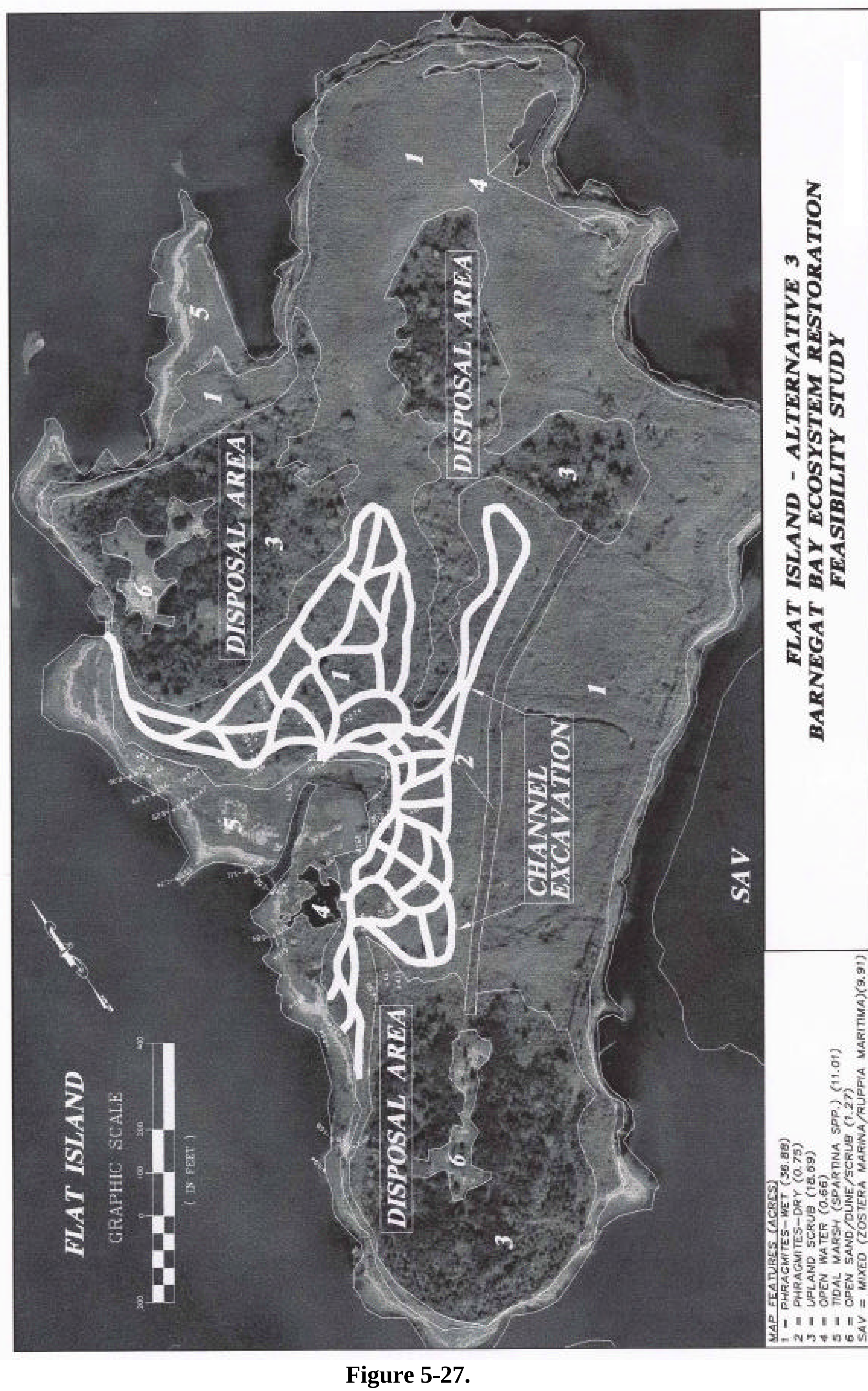

FLAT ISLAND - ALTERNATIVE 3
BARNEGAT BAY ECOSYSTEM RESTORATION
FEASIBILITY STUDY
FLAT ISLAND
GRAPHIC SCALE
(IN FEET)
DISPOSAL AREA
DISPOSAL AREA
DISPOSAL AREA
CHANNEL
EXCAVATION
SAV
MAP FEATURES (ACRES)
1 = PHRAGMITES-WET (36.88)
2 = PHRAGMITES-DRY (0.75)
3 = UPLAND SCRUB (18.69)
4 = OPEN WATER (0.66)
5 = TIDAL MARSH (SPARTINA SPP.) (11.01)
6 = OPEN SAND/DUNE/SCRUB (1.27)
SAV = MIXED (ZOSTERA MARINA/RUPPIA MARITIMA)(9.91)

Figure 5-27.

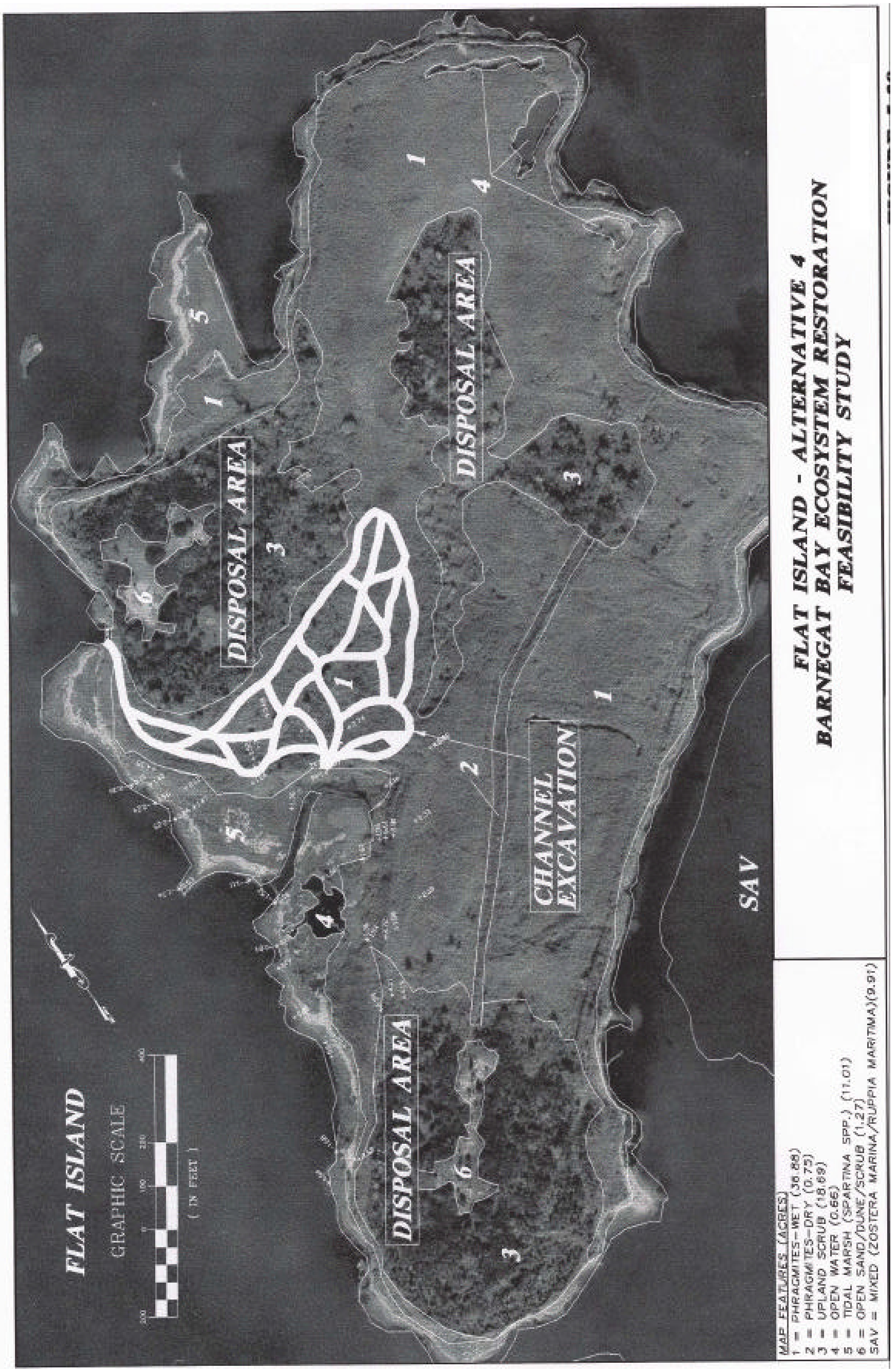

FLAT ISLAND - ALTERNATIVE 4
BARNEGAT BAY ECOSYSTEM RESTORATION
FEASIBILITY STUDY
DISPOSAL AREA
DISPOSAL AREA
DISPOSAL AREA
CHANNEL EXCAVATION
SAV
FLAT ISLAND
GRAPHIC SCALE
(IN FEET)
MAP FEATURES (ACRES)
1 = PHRAGMITES-WET (36.88)
2 = PHRAGMITES-DRY (0.75)
3 = UPLAND SCRUB (18.69)
4 = OPEN WATER (0.66)
5 = TIDAL MARSH (SPARTINA SPP.) (11.01)
6 = OPEN SAND/DUNE/SCRUB (1.27)
SAV = MIXED (ZOSTERA MARINA/RUPPIA MARITIMA)(9.91)

Figure 5-28.

habitats for a suite of marsh birds (marsh wren, sharp-tailed sparrow, seaside sparrow) and other wildlife. The goals would be realized by opening the site to tidal, saline Bay water through a system of open channels that would connect to existing high quality tidal marsh. All of the channels would be cut primarily through dense, nontidal phragmites marsh. As determined in Cycle 3 (Harriott and Southerland 2001), a roughly 8-acre parcel of high quality tidal marsh exists on the western side of Flat Island; a narrow fringe of tidal marsh also rings the periphery of the island. The existing tidal marsh habitat would likely provide for recruitment of new marsh plants to the project and serve as an excellent "benchmark" for success of the proposed project.

The three alternatives differ primarily in the complexity of their proposed channel systems and the extent of high quality tidal marsh that would be created. Flat Island has been used in the past for dredged material disposal and a portion of it remains a critical disposal site for future disposal actions. Alternatives 2 and 3 (particularly Alternative 3) would allow for larger future disposal areas, but would result in creation of smaller areas of new tidal marsh. The following are the proposed alternatives for Flat Island.

Alternative 1. No Action. The existing conditions at the site would remain unchanged.

Alternative 2. This alternative consists of excavating a meandering and braided open channel system throughout a total area of approximately 13.8 acres in the western and northwestern portions of the island (Figure 5-26). The channel system will be approximately 13,000 feet in length, with the average cross-section including 70 square feet below MLW and 130 square feet above MLW. Based on the area in direct contact with tidal exchange and the capillary fringe, this alternative would result in tidal marsh re-creation of approximately 13 acres.

Alternative 3. This alternative consists of excavating a meandering and braided open channel system throughout a total area of approximately 10.7 acres in the western portions of the island (Figure 5-27). The channel system will be approximately 10,000 feet in length with the average cross-section including 70 square feet below MLW and 130 square feet above MLW. Based on the area in direct contact with tidal exchange and the capillary fringe, this alternative would result in tidal marsh re-creation of approximately 10 acres.

Alternative 4. This alternative consists of excavating a meandering and braided open channel system throughout a total area of approximately 5.6 acres in the western portions of the island (Figure 5-28). The channel system will be approximately 5,000 feet in length with the average cross-section including 70 square feet below MLW and 130 square feet above MLW. Based on the area in direct contact with tidal exchange and the capillary fringe, this alternative would result in tidal marsh re-creation of approximately 5 acres.

5.4.2 Habitat Unit Calculations

As previously indicated in Chapter 4, a total of eight species or suites of species (marsh wren; seaside sparrow; sharp-tailed sparrow; piping plover; suite of Barnegat Bay juvenile fish and benthic invertebrates; diamondback terrapin; anadromous and catadromous fish; and black duck) were selected to represent the habitat problems and restoration opportunities at each of the six

project sites. Chapter 4 described (1) the habitat preferences for each of the six species, (2) the method for designating habitat units of ecosystem restoration from these preferences, (3) the current number of desired habitat units at each site, and (4) recommendations for restoration to increase these habitat units.

Following this approach, the desired habitats of high ecological integrity to be created by each alternative were mapped using a GIS. Using final conceptual layouts drawn on high quality, low altitude black-and-white aerial photographs (flown in 1998), the size and configuration of each of these created habitats was estimated for each alternative by Versar wetland scientists, wildlife biologists, and fisheries biologists with field experience at the project sites. The extent and arrangement of each created habitat was based on changes in hydrology and vegetation expected to result from implementation of the alternative. Each of the habitats to be created was mapped by hand directly onto the aerial photographs and then digitized in a GIS for data manipulation.

The maps were then used to calculate the specific habitat units (derived from habitat preferences of species representative of high ecological integrity) to be created by each alternative. These resultant restoration outputs are summarized for all alternatives at all project sites in Table 5-1. Detailed results for each project site are presented individually in Tables 5-2 through 5-7. In addition to the quantity of each habitat type (acres) to be created under each alternative, these tables describe the changes in existing vegetation and land cover expected to result from the restoration activities. The current number of habitat units present at each site are shown under each project's No-Action Alternative (Alternative 1).

As discussed in Chapter 4, the habitat assessment procedure developed for this feasibility study uses these representative species as surrogates for the natural, high ecological integrity conditions that occurred before human disturbance. Implicit in this ecosystem approach is the fact that the benefits resulting from the proposed restorations would not be limited to these selected species. Other fish and other wildlife species would benefit and, in addition, many ecosystem-level benefits, such as improvement of Barnegat Bay water quality, increased connectivity of native habitats, and more natural ecological processes (e.g., hydrology and nutrient cycling), would also result from the proposed restorations. While it is not possible to determine the number of each species that are likely to benefit from each restoration, nor to quantify improvements in ecosystem functioning, increases in the number of species of concern should be related to the number of breeding pairs that use an acre of restored habitat. Based on literature values for breeding ranges, one acre of restored tidal marsh could produce 8 pairs of seaside sparrows, salt marsh sparrows, sharp-tailed sparrows, and marsh wrens (Hess *et al.* 2000, Gutzwiller and Anderson 1987); one acre of vegetated pond habitat, 4 pairs of black and other dabbling ducks (Lewis and Garrison 1984); one acre of beach pond habitat, 2 pairs of piping plovers (Cairns and McLaren 1980); and one acre of sandy shore habitat, 185 diamondback terrapin nests (Palmer and Cordes 1988).

Table 5-1

Summary of the ecological benefits to be created under each alternative for the six Barnegat Bay ecosystem restoration projects. Ecological benefits are measured in units of habitat preferred by selected species representative of high ecological integrity conditions. Each type of habitat unit is weighted equally in totaling ecological benefits for the alternatives.

Barnegat Bay Ecosystem Restoration Project Alternatives	Ecological Benefits in Habitat Units (acres)							
	Fish and Benthic Communities	Diamondback Terrapin	Fish and Benthic and Black Duck	Tidal Marsh (as represented by bird species of concern)	Piping Plover	Anadromous Fishery (river herring and American eel)	Black Duck (and other dabbling ducks)	Total Habitat Units Created
F&L Abandoned Lagoons								
Alt. 1 No Action	0	0						0
2	8.20	2.30						10.50
3	8.45	3.27						11.72
4	8.20	2.30						10.50
5	8.45	3.27						11.72
Bayville Abandoned Lagoon								
Alt 1 No Action			0					0
2			4.43					4.43
3			4.68					4.68
4			4.79					4.79
Oyster Creek								
Alt. 1 No Action		5.00		0				0
2		10.14		9.23				19.37
3		10.14		18.31				28.45
4		10.14		24.86				35.00
Barnegat Lighthouse								
Alt. 1 No Action					0			0
2a					6.40			6.40
2b					6.23			6.23
3a					2.95			2.95
3b					2.77			2.77
4a					6.72			6.72
4b					6.23			6.23
5a					3.36			3.36
5b					2.77			2.77
Stafford Forge								
Alt 1 No Action						0	0	0
2						56.28	0	56.28
3						62.94	0	62.94
4						113.57	0	113.57
5						56.28	70.86	127.14
6						62.94	70.86	133.80
7						113.47	70.86	184.43
8						0	70.86	70.86

Table 5-1 Cont'd								
Barnegat Bay Ecosystem Restoration Project Alternatives	Ecological Benefits in Habitat Units (acres)							
	Fish and Benthic Communities	Diamondback Terrapin	Fish and Benthic and Black Duck	Tidal Marsh (as represented by bird species of concern)	Piping Plover	Anadromous Fishery (river herring and American eel)	Black Duck (and other dabbling ducks)	Total Habitat Units Created
Flat Island								
Alt. 1 No Action				0				0
2				13.36				13.36
3				10.08				10.08
4				5.30				5.30

5.4.3 Alternative Plans Cost Estimates

The estimated costs of the alternative plans for each of the sites considered are shown in detail in Tables 16.1 to 16.28 in Appendix E, Engineering Technical Appendices, Section 16 - Cost Estimate. A summary of the estimated costs is presented in Table 5-8.

5.4.4 Incremental Cost Analysis

The purpose of this investigation is to conduct cost effectiveness and incremental cost analyses (CE/ICA) to help identify the most effective and efficient ecosystem restoration plans for the six ecosystem restoration sites. The use of CE/ICA will not necessarily result in identification of a single optimal plan.

5.4.4.1 Cost Effectiveness and Incremental Cost Analyses

Ecosystem restoration projects differ from traditional USACE planning studies, since their benefits typically cannot be expressed in monetary terms. In practice, USACE ecosystem restoration studies often measure the ecosystem benefits of alternative plans in terms of physical dimensions, population counts, or various habitat-based scores. To promote effective decision making for ecosystem restoration projects, USACE environmental planning has incorporated CE/ICA to compare the relative costs and outputs of alternative ecosystem restoration plans.

USACE ecosystem restoration policies require that restoration projects include CE/ICA to aid in the decision making process by evaluating possible combinations of management measures. Specifically, CE/ICA can be used to support ecosystem restoration studies through the: (1) formulation of alternative plans, (2) evaluation of their effects, and (3) identification of the plan which best meets restoration objectives at the least cost.

Table 5-2

F&L ABANDONED LAGOONS - Comparison of new fish and wildlife habitats likely to result from implementing each alternative at the F&L Abandoned Lagoons (LAN05/LAN06) site. Alternative 1 (No-Action) presents the existing conditions at the site (including the current acres of fish and wildlife habitat present and the acres of vegetation and land cover that comprise the portion of the site to be restored). The action alternatives at this site would each benefit a suite of native juvenile fish and benthic invertebrates, as well as the diamondback terrapin. The changed areal extent (and percent of original extent) of vegetation and land cover that would result from creating the new fish and wildlife habitats are also presented.

	Changes in Habitats as Depicted by Vegetation and Land Cover Types (Acres)								Habitat Units Created	
	Open Water* < 6' Deep	Open Water > 6' Deep	Phragmites Wet	Phragmites Dry	Phragmites Pond	Scrub Forest	Open** Sand	Total Acreage	Fish and Benthic	Terrapin
No Action Alternative 1	1.00	6.73	0.98	0.13	0.25	13.54	0.00	23.63	0.00	0.00
Alternative 2	9.20	0.22	0.93	0.13	0.10	10.75	2.30	23.63	8.20	2.30
Alternative 3	9.45	0.22	0.98	0.06	0.23	9.42	3.27	23.63	8.45	3.27
Alternative 4	9.20	0.22	0.93	0.13	0.10	10.75	2.30	23.63	8.20	2.30
Alternative 5	9.45	0.22	0.98	0.02	0.23	9.42	3.27	23.63	8.45	3.27

*Open water less than six feet deep provides optimal habitat for the targeted species (fish and benthic organisms).

**Open sand provides optimal nesting habitat for the diamondback terrapin.

Table 5-3

BAYVILLE ABANDONED LAGOON - Comparison of new fish and wildlife habitats likely to result from each alternative at the Bayville Abandoned Lagoon (LAC02) site. Alternative 1 (No-Action) presents the existing conditions at the site (including the current acres of fish and wildlife habitat present and the acres of vegetation and land cover that comprise the portion of the site to be restored). The action alternatives at this site would each benefit a suite of native juvenile fish and benthic organisms, as well as black duck (and other dabbling ducks). The changed areal extent (and percent of original extent) of vegetation and land cover that would result from creating the new fish and wildlife habitats are also presented.

	Changes in Habitats as Depicted by Vegetation and Land Cover Types (Acres)							Habitat Units Created
	Open Water* < 6' Deep	Open Water > 6' Deep	Phragmites Wet	Forest	Tidal Marsh	Dirt Road	Total Acreage	Fish and Benthic/ Black Duck
No Action Alternative 1	2.00	1.98	5.00	8.44	10.18	0.33	29.93	0.00
Alternative 2	6.43	0.48	4.28	8.44	9.97	0.33	29.93	4.43
Alternative 3	6.68	0.48	4.22	8.25	9.97	0.33	29.93	4.68
Alternative 4	6.79	0.48	4.02	8.34	9.97	0.33	29.93	4.79

*Open water less than six feet deep provides optimal habitat for the targeted species (fish and benthic organisms and black duck).

Table 5-4

OYSTER CREEK - Comparison of new fish and wildlife habitats likely to result from each alternative at the Oyster Creek (TWC21) site. Alternative 1 (No-Action) presents the existing conditions at the site (including the current acres of fish and wildlife habitat present and the acres of vegetation and land cover that comprise the portion of the site to be restored). The action alternatives at this site would each benefit seaside sparrow, sharp-tailed sparrow, marsh wren (as well as other marsh nesting birds), and diamondback terrapin. The changed areal extent (and percent of original extent) of vegetation and land cover that would result from creating the new fish and wildlife habitats are also presented.

	Changes in Habitats as Depicted by Vegetation and Land Cover Types (Acres)						Habitat Units Created	
	Open* Sand	Tidal** Marsh	Open Water	Phragmites Scrub	Phragmites Marsh	Total Acreage	Terrapin	Salt Marsh Birds
No Action Alternative 1	5.00	0.00	12.58	10.50	74.99	103.07	5.00	0.00
Alternative 2	15.14	9.23	12.58	0.36	65.66	103.07	10.14	9.23
Alternative 3	15.14	18.31	12.58	0.36	56.68	103.07	10.14	18.31
Alternative 4	15.14	24.86	12.58	0.36	50.13	103.07	10.14	24.86

*Open sand provides optimal nesting habitat for the diamondback terrapin.

**Tidal marsh provides optimal habitat for targeted salt marsh birds (marsh wren, seaside sparrow, and sharp-tailed sparrow).

Table 5-5

BARNEGAT LIGHTHOUSE - Comparison of new fish and wildlife habitats likely to result from each alternative at the Barnegat Lighthouse (TWS39) site. Alternative 1 (No-Action) presents the existing conditions at the site (including the current acres of fish and wildlife habitat present and the acres of vegetation and land cover that comprise the portion of the site to be restored). The action alternatives at this site would each benefit piping plover (a listed Federal Threatened species), as well as other shorebirds. The changed areal extent (and percent of original extent) of vegetation and land cover that would result from creating the new fish and wildlife habitats are also presented.

	Changes in Habitats as Depicted by Vegetation and Land Cover Types (Acres)					Habitat Units Created
	Intertidal* Shallow Water	Dune	Beach	Phragmites	Total Acreage	Piping Plover
No Action Alternative 1	0.50	60.21	9.50	19.02	89.23	0.00
Alternative 2a	6.90	55.41	9.42	17.50	89.23	6.40
Alternative 2b	6.73	55.50	9.50	17.50	89.23	6.23
Alternative 3a	3.45	57.65	9.42	18.71	89.23	2.95
Alternative 3b	3.27	57.75	9.50	18.71	89.23	2.77
Alternative 4a	7.22	55.18	9.33	17.50	89.23	6.72
Alternative 4b	6.73	55.50	9.50	17.50	89.23	6.23
Alternative 5a	3.86	57.16	9.50	18.71	89.23	3.36
Alternative 5b	3.27	57.75	9.50	18.71	89.23	2.77

*Intertidal shallow water provides optimal feeding habitat for the Federally threatened piping plover.

Table 5-6

STAFFORD FORGE - Comparison of new fish and wildlife habitats likely to result from each alternative at the Stafford Forge (NWS02) site. Alternative 1 (No-Action) presents the existing conditions at the site (including the current acres of fish and wildlife habitat present and the acres of vegetation and land cover that comprise the portion of the site to be restored). The proposed actions would benefit river herring (alewife and blueback herring), as well as black duck (and other dabbling ducks). The changed areal extent (and percent of original extent) of vegetation and land cover that would result from creating the new fish and wildlife habitats are also presented.

	Changes in Habitats as Depicted by Vegetation and Land Cover Types (Acres)				Habitat Units Created	
	Shallow* Water/Marsh	Stream** Channel	Open Water	Total Acreage	Black Duck	Anadromous Fish
No Action Alternative 1	5.00	0.00	184.57	189.57	0.00	0.00
Alternative 2	5.00	56.28	128.31	189.57	0.00	56.28
Alternative 3	5.00	62.94	121.63	189.57	0.00	62.94
Alternative 4***	5.00	113.57	71.30	189.57	0.00	113.57
Alternative 5	75.86	56.28	57.77	189.57	70.86	56.28
Alternative 6	75.86	62.94	51.11	189.57	70.86	62.94
Alternative 7***	75.86	113.57	0.44	189.57	70.86	113.57
Alternative 8	75.86	0.00	113.71	189.57	70.86	0.00

*Shallow water (< 6' deep) with herbaceous marsh provide optimal habitat for black duck.

**Stream channel with unhindered passage provides optimal habitat for anadromous fish (river herring) and catadromous eel.

***Note that approxi mately 10.2 acres of upstream habitat above the site would also be opened up for fish passage under these alternatives.

Table 5-7

FLAT ISLAND - Comparison of new fish and wildlife habitats likely to result from each alternative at the Flat Island (ISS02) site. Alternative 1 (No-Action) presents the existing conditions at the site (including the current acres of fish and wildlife habitat present and the acres of vegetation and land cover that comprise the portion of the site to be restored). The action alternatives at this site would each benefit seaside sparrow, sharp-tailed sparrow, and marsh wren (as well as other marsh nesting birds). The changed areal extent (and percent of original extent) of vegetation and land cover that would result from creating the new fish and wildlife habitats are also presented.

	Changes in Habitats as Depicted by Vegetation and Land Cover Types (Acres)			Habitat Units Created
	Tidal* Marsh	Phragmites Wet	Total Acreage	Salt Marsh Birds
No Action				
Alternative 1	10.00	36.88	46.88	0.00
Alternative 2	23.36	23.52	46.88	13.36
Alternative 3	20.08	26.80	46.88	10.08
Alternative 4	15.30	31.58	46.88	5.30

*Tidal marsh provides optimal habitat for targeted salt marsh birds (marsh wren, seaside sparrow, and sharp-tailed sparrow).

Table 5-8 Summary of Estimated Construction Costs (January 2002 Price Level)	
F&L Abandoned Lagoons	
Alternative 1 (No Action)	$0
Alternative 2	$934,300
Alternative 3	$945,400
Alternative 4	$946,400
Alternative 5	$957,500
Bayville Abandoned Lagoon	
Alternative 1 (No Action)	$0
Alternative 2	$630,700
Alternative 3	$688,600
Alternative 4	$686,600
Oyster Creek	
Alternative 1 (No Action)	$0
Alternative 2	$957,000
Alternative 3	$1,996,500
Alternative 4	$3,251,600
Barnegat Lighthouse	
Alternative 1 (No Action)	$0
Alternative 2A	$1,885,100
Alternative 2B	$1,871,900
Alternative 3A	$905,200
Alternative 3B	$899,200
Alternative 4A	$2,040,300
Alternative 4B	$2,026,500
Alternative 5A	$1,079,800
Alternative 5B	$1,055,000
Stafford Forge	
Alternative 1 (No Action)	$0
Alternative 2	$127,600
Alternative 3	$145,600
Alternative 4	$174,700
Alternative 5	$193,600
Alternative 6	$211,100
Alternative 7	$240,300
Alternative 8	$79,400
Flat Island	
Alternative 1 (No Action)	$0
Alternative 2	$2,636,300
Alternative 3	$2,014,100
Alternative 4	$1,160,000

CE/ICA generates information that supports sound financial investments by comparing the costs and non-monetary outputs (benefits) of alternative investment choices. CE/ICA is conducted in a series of steps that progressively identify alternatives that meet specified criteria and screen out those that do not. These analyses help determine whether the additional environmental outputs for increasing levels of restoration are worth the additional monetary cost. Although neither cost effectiveness analysis (CEA) nor incremental cost analysis (ICA) necessarily result in the identification of a single "best" alternative, they contribute to informed decision making for ecosystem restoration.

As shown in Figure 5-29, CEA evaluates the full range of alternative plans. For environmental projects, outputs are typically expressed in physical units (e.g., hydrologic indicators) or biological units (e.g., habitat units). As illustrated in Figure 5-29, there may be many plans that could generate the environmental outputs desired for a particular ecosystem restoration project. These plans may be comprised of one or more structural or nonstructural measures.

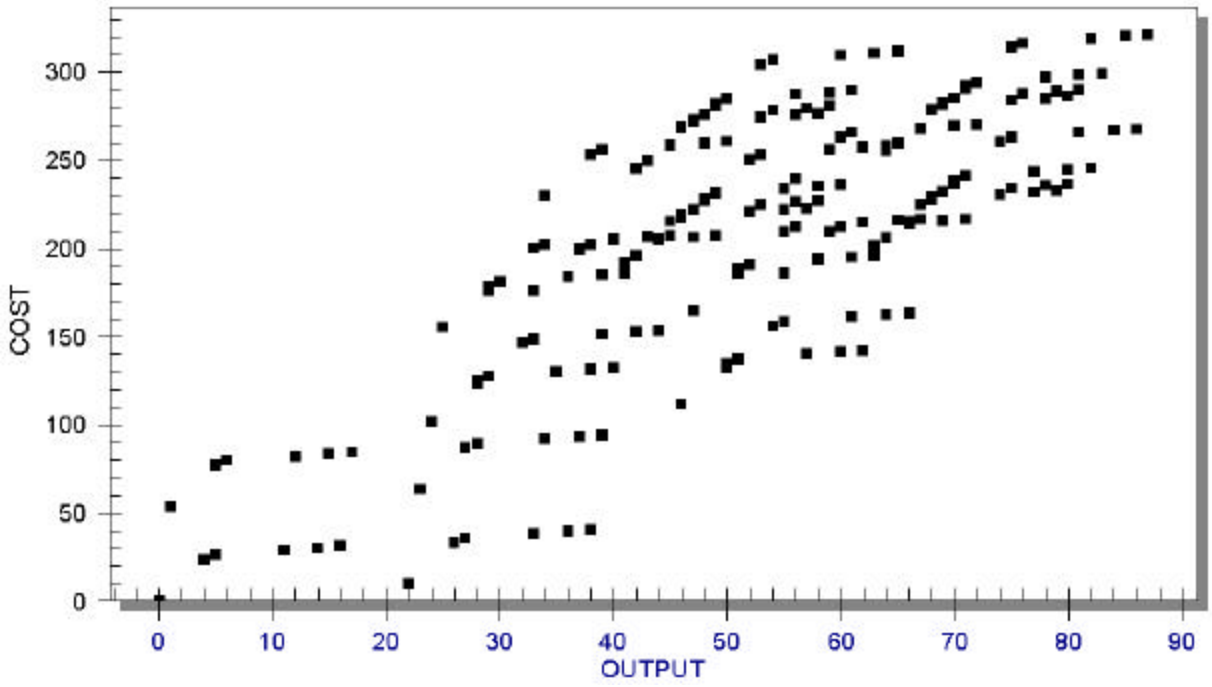


Figure 5-29. Example – All Plans

CEA begins with a comparison of the costs and outputs of alternative plans to identify the least cost plan for every possible level of restoration output. CEA screens out plans that are inefficient or ineffective. Figure 5-30 illustrates how inefficient and ineffective plans are eliminated through CEA. As shown in this figure, Plan A produces the same amount of environmental output as Plan B, but at a higher cost. Plan A is therefore inefficient relative to Plan B and would be eliminated through the CEA process. The comparison of Plan C and Plan D indicates that Plan D produces more environmental outputs than Plan C at the same cost. Plan

C is therefore ineffective relative to Plan D and would also be eliminated by the CEA process. The result of CEA is a cost effectiveness curve that consists of the most economically efficient plans for various output levels (see Figure 5-31).

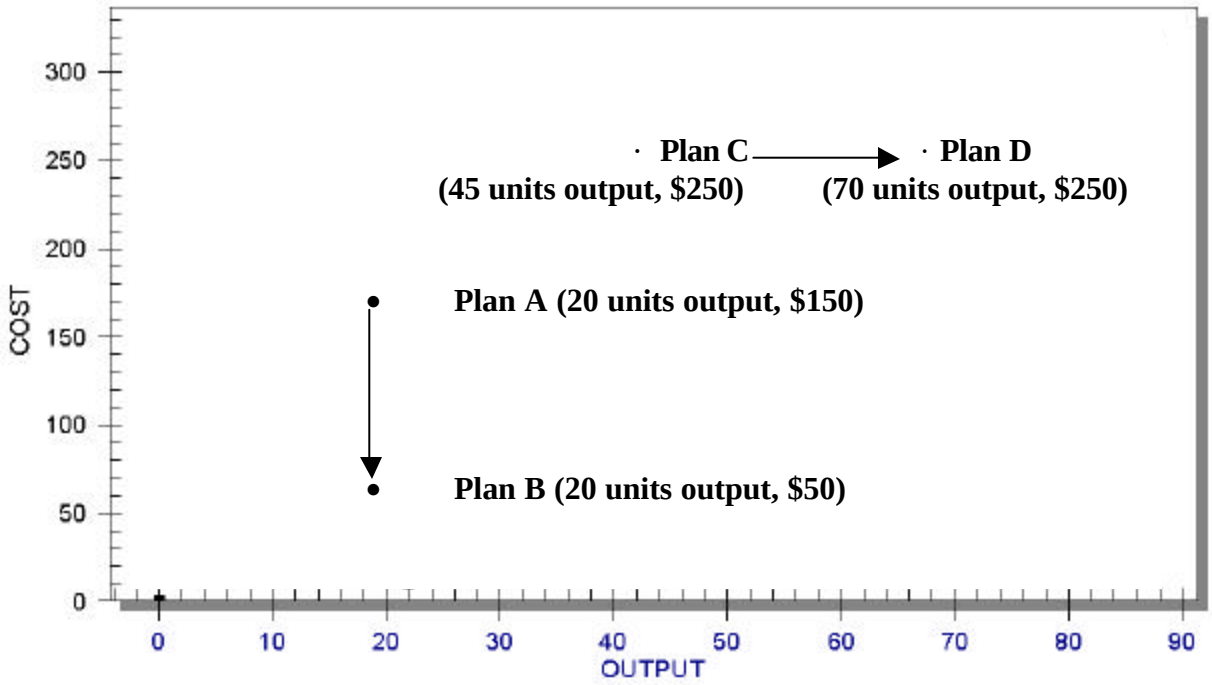


Figure 5-30. Example – Screening of Plans

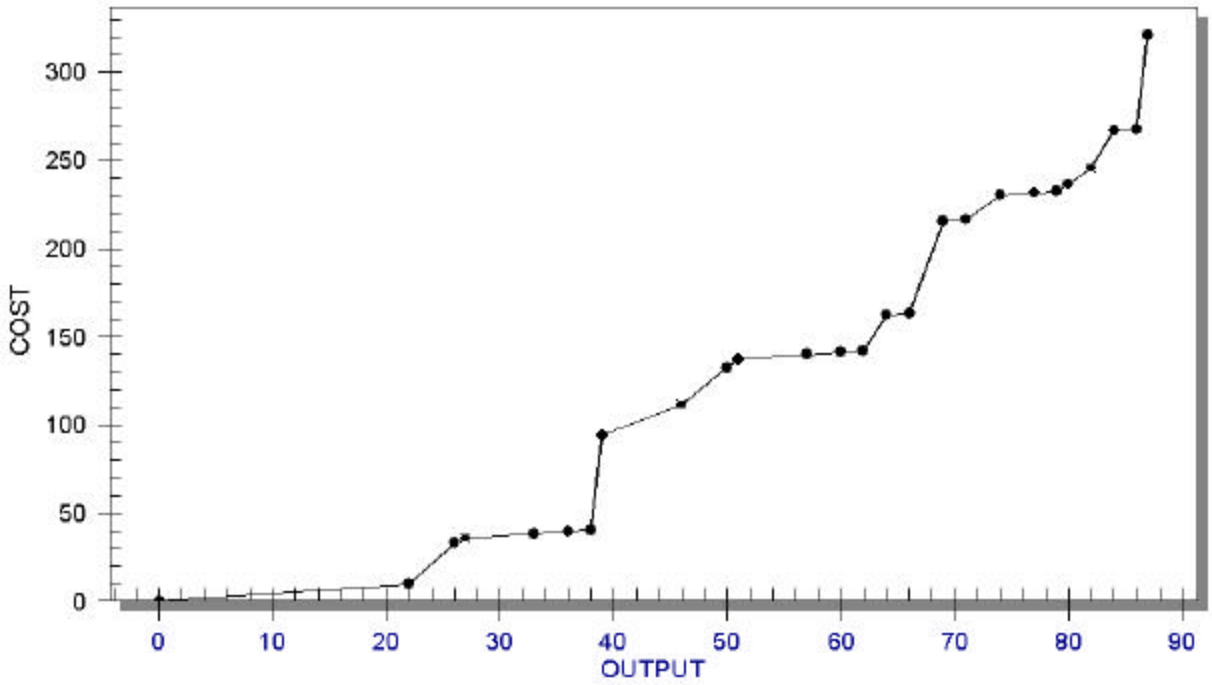


Figure 5-31. Example – Cost Effective Plans

After the cost effectiveness of the alternatives has been established, ICA can be used to reveal and evaluate incremental changes in costs for increasing levels of environmental output. The primary purpose of ICA is to explicitly compare the incremental costs and the incremental outputs associated with each successively larger restoration plan (see Figure 5-32). The explicit comparisons of incremental costs and outputs allow evaluation of alternative scales of plans and plan components. The incremental evaluation of project costs and outputs provides more insight than average or total costs, since it can be used to identify significant increases in project costs necessary to achieve additional units of ecological output for the full range of ecosystem restoration plans. CE/ICA does not provide a discrete decision criterion (i.e., it does not identify the "best" plan). However, it does provide information to decision makers which allows explicit comparisons between the relative changes in costs and outputs for each plan.

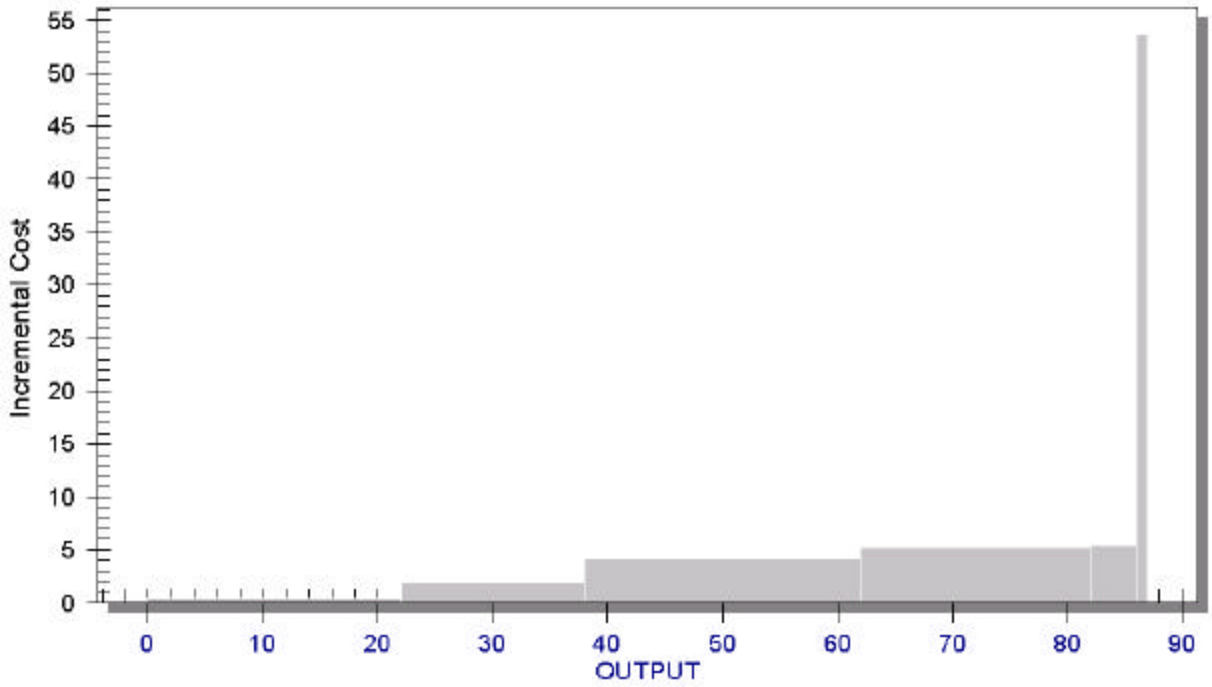


Figure 5-32. Example – Best Buy Plans

The advantages of CE/ICA are that it ensures a rational approach for considering and selecting alternative methods to produce environmental outputs. It also provides decision makers with a range of implementable alternatives of varying scales, rather than an all-or-nothing choice, and it specifies the most cost effective plans for various output levels.

5.4.4.2 IWR-PLAN Decision Support Software

The USACE Institute for Water Resources has developed a computer model, *IWR-PLAN*, to facilitate incorporation of CE/ICA into the planning process. This software builds upon previous USACE CE/ICA efforts, such as (1) Evaluation of Environmental Investments Procedures Manual, Interim: Cost Effectiveness and Incremental Cost Analyses, May 1995, IWR Report

#95-R-1 and (2) the *ECO-EASY* software which provided an earlier version of the model in DOS format.

IWR-PLAN can be used to: (1) formulate alternative plans by evaluating potential combinations of restoration measures and a variety of scales of individual measures, (2) perform CEA of the spectrum of potential restoration plans, and (3) conduct ICA on cost effective plans. The costs and outputs associated with each plan are input by the user. The user specifies structural or nonstructural management measures, plans (combinations of measures); or programs (combinations of plans often at the regional or national level), and potential scales of each measure.

The purpose of CE/ICA is to explicitly compare the incremental costs and the incremental outputs associated with moving to each successively larger restoration plan. Internally, *IWR-PLAN* calculates: (1) incremental costs by subtracting the cost of the last alternative under consideration from the cost of the next largest plan and (2) incremental outputs by subtracting the output of the last alternative under consideration from the output of the next largest plan. *IWR-PLAN* then automatically identifies the plan that produces the lowest average cost per unit of output when compared to the No Action plan. In the next step, all larger plans are compared incrementally to the lowest average cost plan. This process identifies the most efficient plan for producing the next higher level of output. All plans between the first and second selected plans are then eliminated. Incremental costs for the remaining larger plans are recalculated compared to the second selected plan. The successive comparison of incremental costs to the previously selected plan continues until the set is complete.

The final set of selected plans is referred to as "best buy plans." The first "best buy" is the most efficient plan, producing ecological outputs at the lowest incremental cost per unit. If a higher level of output is desired for reasons other than cost efficiency, then successive "best buy" plans can be considered for implementation.

5.4.4.3 CE/ICA of Barnegat Bay Sites

The results of the CE/ICAs conducted for each of the six Barnegat Bay sites are summarized below in separate sections. The sites are discussed in the following sequence: F&L Abandoned Lagoons, Bayville Abandoned Lagoon, Oyster Creek, Barnegat Lighthouse, Stafford Forge, and Flat Island.

Each section includes descriptions of the alternative plans, profiles of their costs and outputs, and results of the CE/ICA. Sites examined were subjected to individual CE/ICAs, using IWR-PLAN Version 3.30 software. Due to the scale of potential restoration action and the distances between sites, no linkages between sites in terms of outputs or costs were evaluated. Costs of the alternative plans include implementation costs (including construction costs, real estate costs, and interest during construction) and operation, maintenance, repair, replacement and rehabilitation (OMRR&R) costs. Costs reflected in the following tables differ uniformly from those found in Appendix E, as project costs were refined throughout the plan formulation process. The differences are generally proportional and do not affect the outcome of the

CE/ICA. Outputs of restoration action are expressed as acres of desired habitat created or improved as a result of restoration action. Outputs of the restoration plans were identified by comparing the alternative plans with the No Action alternative (i.e., with- vs. without-project conditions) at the six sites.

5.4.4.4 F&L Abandoned Lagoons

The alternative restoration plans formulated for the F&L Abandoned Lagoons are profiled in Table 5-9. The restoration goals for this site are to improve water quality and physical bottom habitat in these lagoons, thereby improving juvenile fish and benthic habitat (as a primary goal), as well as to improve diamondback terrapin habitat (as a secondary goal). These goals can be achieved via enhanced circulation and reduction in water depths. The four alternative plans for the F&L Abandoned Lagoons include combinations of the following features: raising the bottom elevation of the lagoons, connecting the lagoons through channels of differing lengths, increasing the depth of the entrance channel to the L lagoon, and creating an island(s) to help establish isolated terrapin habitat. As indicated in Table 5-9, the outputs of the alternative plans for the F&L Abandoned Lagoons are expressed in acres of fish and benthic habitat and diamondback terrapin habitat.

TABLE 5-9
OUTPUTS OF ALTERNATIVE RESTORATION PLANS
F&L ABANDONED LAGOONS

Alternative Restoration Plans	Restoration Features	Restoration Outputs* Fish & Benthic Habitat & Diamondback Terrapin (acres)
Alternative 1 (No Action)	n.a.	n.a.
Alternative 2	500 feet of excavated channel to connect lagoons	10.50 (fish & benthic – 8.20) (terrapin – 2.30)
Alternative 3	670 feet of excavated channel to connect lagoons	11.72 (fish & benthic – 8.45) (terrapin – 3.27)
Alternative 4	In addition to Alternative 2: deepening entrance channel to L Lagoon	10.50 (fish & benthic – 8.20) (terrapin – 2.30)
Alternative 5	In addition to Alternative 3: deepening entrance channel to L Lagoon	11.72 (fish & benthic – 8.45) (terrapin – 3.27)

* Additional ecological outputs directly resulting from restoration action

The total average annual costs of the F&L Abandoned Lagoons alternative plans are presented in Table 5-10. These costs are based on average annual implementation costs and annual OMRR&R costs. Average annual implementation costs include capital costs, real estate costs, and interest during construction.

TABLE 5-10
COSTS OF ALTERNATIVE PLANS
F&L ABANDONED LAGOONS

Alternative Restoration Plans	Implementation Costs			OMRR&R Costs	Total Average Annual Costs
	Total Project First Cost	Interest During Construction	Average Annual Equivalent Cost**		
Alternative 1 (No Action)	$0	$0	$0	$0	$0
Alternative 2	$834,600	$12,694	$67,100	$0	$67,100
Alternative 3	$845,700	$12,814	$68,000	$0	$68,000
Alternative 4	$845,000	$12,803	$67,900	$5,400	$73,300
Alternative 5	$856,100	$12,970	$68,800	$5,400	$74,200

* Includes construction and real estate costs
** 25 years at 6.125 percent

The average costs of the F&L Abandoned Lagoons alternative plans in dollars per acre are presented in Table 5-11 and illustrated in Figure 5-33. The CEA eliminated Alternative 4 and Alternative 5, since their levels of output could be more efficiently achieved by Alternative 2 and Alternative 3, respectively. Consequently, Alternative 2 and Alternative 3 (and the No Action alternative) were carried forward to the ICA.

TABLE 5-11
AVERAGE COSTS OF ALTERNATIVE RESTORATION PLANS
F&L ABANDONED LAGOONS

Alternative Restoration Plans*	Outputs (acres)	Average Annual Costs ($)	Average Cost ($/acre)
Alternative 1 (No Action)	0	$0	$0
Alternative 2	10.50	$67,100	$6,390
Alternative 4**	10.50	$73,300	$6,980
Alternative 3	11.72	$68,000	$5,800
Alternative 5**	11.72	$74,200	$6,330

* Plans ranked by output
** Eliminated by CEA

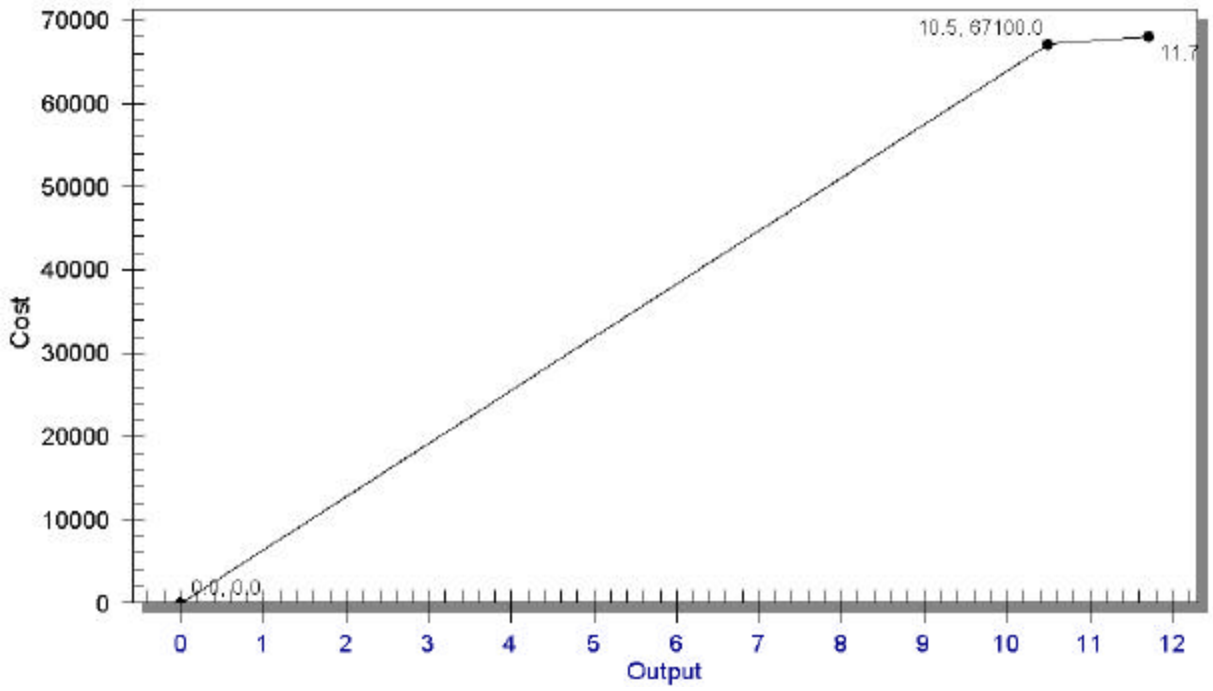


Figure 5-33. F&L Abandoned Lagoons – Cost Effective Plans

The results of ICA for F&L Abandoned Lagoons are presented in Table 5-12 and illustrated in Figure 5-34. As indicated in the table and figure, Alternative 3 was identified by the ICA as the single Best Buy plan for F&L Abandoned Lagoons.

TABLE 5-12
BEST BUY RESTORATION PLANS
F&L ABANDONED LAGOONS

Alternative Restoration Plans*	Outputs (acres)	Average Annual Costs ($)	Average Cost ($/acre)	Incremental Costs ($)	Incremental Output (acres)	Incremental Cost per Output ($/acre)
Alternative 3	11.72	$68,000	$5,800	$68,000	11.72	$5,800

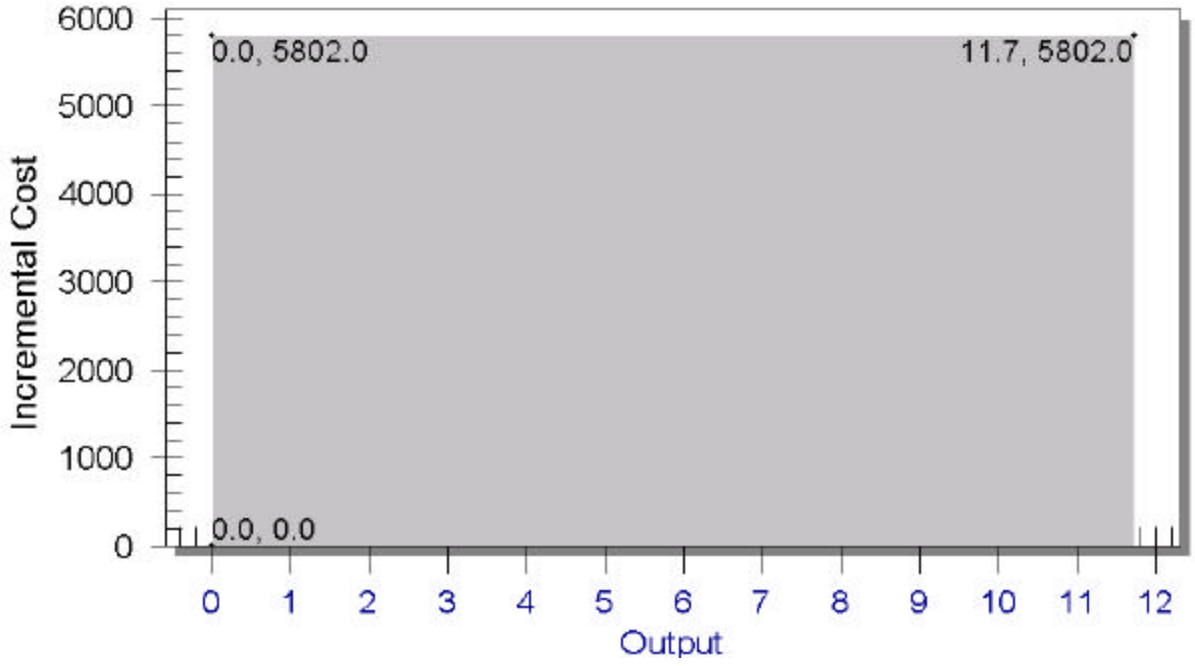


Figure 5-34. F&L Abandoned Lagoons – Best Buy Plans

5.4.4.5 Bayville Abandoned Lagoon

The alternative plans formulated for the Bayville Abandoned Lagoon are profiled in Table 5-13. The restoration goals for this site are to: (1) improve juvenile fish and benthic habitat (primary goal), (2) create additional submerged aquatic vegetation (secondary goal), and (3) restore tidal marsh (tertiary goal). These goals would be achieved by inducing tidal circulation and reducing water depths in the lagoon. The alternative plans include raising the bottom elevation of the lagoon, connecting the western end of the lagoon to the Bay with an open channel, and connecting the east end of the lagoon by various culvert/channel systems. As indicated in Table 5-13, the outputs of the alternative plans for the Bayville Abandoned Lagoon are expressed in acres of improved fish, benthic, and black duck habitat.

The total average annual costs of the Bayville Abandoned Lagoon alternative plans are presented in Table 5-14. These costs are based on average annual implementation costs and annual OMRR&R costs. Average annual implementation costs include capital costs, real estate costs, and interest during construction.

The average costs of the Bayville Abandoned Lagoon alternative plans in dollars per acre are presented in Table 5-15 and illustrated in Figure 5-35. The CEA determined that Alternative 3 was not cost effective. Specifically, Alternative 3 is ineffective relative to Alternative 4, which would result in greater output at less cost. As a result, Alternative 2 and Alternative 4 (and the No Action alternative) were carried forward to ICA.

TABLE 5-13
OUTPUTS OF ALTERNATIVE RESTORATION PLANS
BAYVILLE ABANDONED LAGOON

Alternative Restoration Plans	Restoration Features	Restoration Outputs* Improved Fish and Benthic Habitat & Black Duck Habitat (Emergent Marsh) (acres)
Alternative 1 (No Action)	n.a.	n.a.
Alternative 2	500-foot long excavated meandering channel; up to 3 culverts; raised bottom elevation of lagoon	4.43
Alternative 3	750-foot long excavated meandering channel along the road; up to 3 culverts; raised bottom elevation of lagoon	4.69
Alternative 4	750-foot long excavated meandering channel near the eastern end of the lagoon; up to 3 culverts; raised bottom elevation of lagoon	4.79

* Additional ecological outputs directly resulting from restoration action

TABLE 5-14
COSTS OF ALTERNATIVE PLANS
BAYVILLE ABANDONED LAGOON

Alternative Restoration Plans	Implementation Costs			OMRR&R Costs	Total Average Annual Costs
	Total Project First Cost	Interest During Construction	Average Annual Equivalent Cost**		
Alternative 1 (No Action)	$0	$0	$0	$0	$0
Alternative 2	$644,100	$6,423	$51,500	$2,800	$54,300
Alternative 3	$662,700	$9,947	$53,200	$2,800	$56,000
Alternative 4	$660,900	$9,920	$53,100	$2,800	$55,900

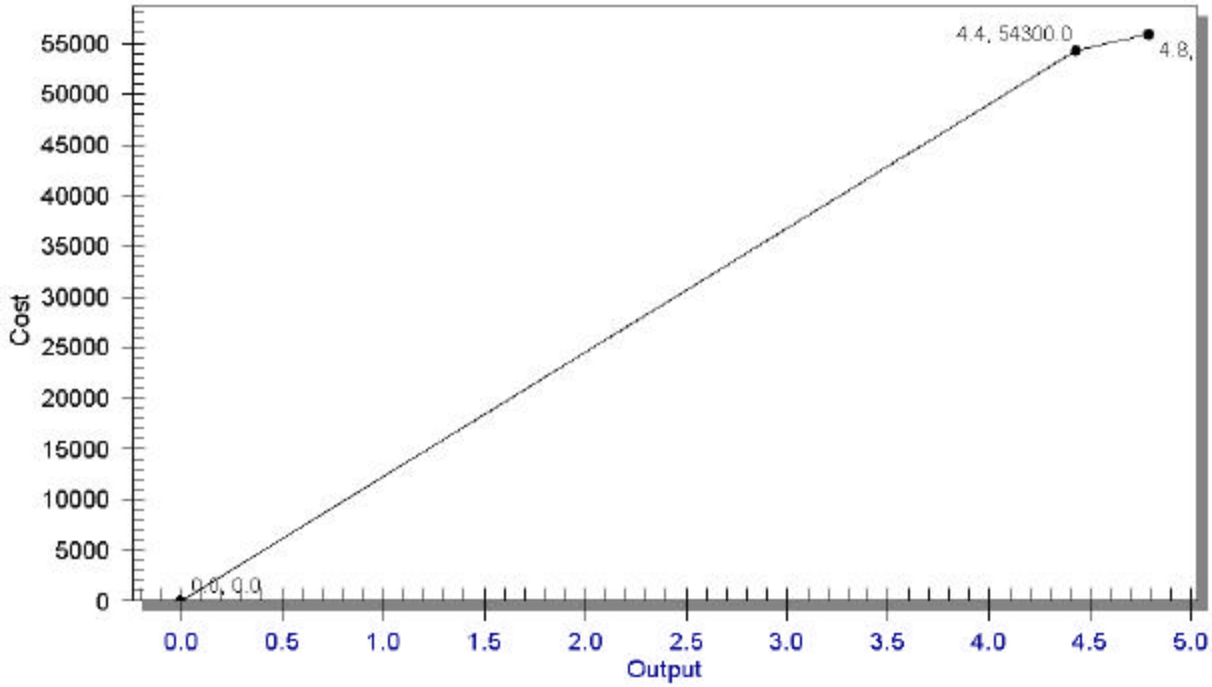
* Includes construction and real estate costs
** 25 years at 6.125 percent

TABLE 5-15
AVERAGE COSTS OF ALTERNATIVE RESTORATION PLANS
BAYVILLE ABANDONED LAGOON

Alternative Restoration Plans	Outputs (acres)	Average Annual Costs ($)	Average Cost ($/acre)
Alternative 1 (No Action)	0	$0	$0
Alternative 2	4.43	$54,300	$12,260
Alternative 3**	4.69	$56,000	$11,940
Alternative 4	4.79	$55,900	$11,670

* Plans ranked by output
** Eliminated by CEA

FIGURE 5-35
BAYVILLE ABANDONED LAGOON – COST EFFECTIVE PLANS



The results of ICA for Bayville Abandoned Lagoon are presented in Table 5-16 and illustrated in Figure 5-36. As indicated in the table and figure, Alternative 4 was identified by the ICA as being the single Best Buy plan for Bayville Abandoned Lagoon.

TABLE 5-16
BEST BUY RESTORATION PLANS
BAYVILLE ABANDONED LAGOON

Alternative Restoration Plans	Outputs (acres)	Average Annual Costs ($)	Average Cost ($/acre)	Incremental Costs ($)	Incremental Output (acres)	Incremental Cost per Output ($/acre)
Alternative 4	4.79	$55,900	$11,670	$55,900	4.79	$11,670

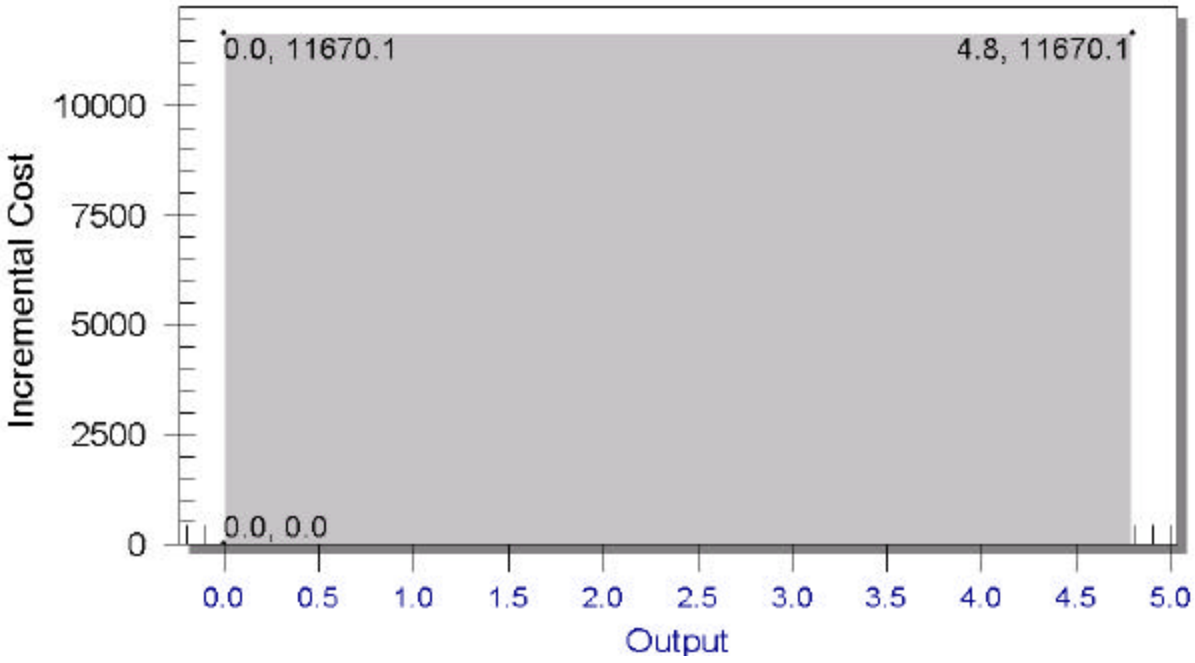


Figure 5-36. Bayville Abandoned Lagoon – Best Buy Plans

5.4.4.6 Oyster Creek

Restoration goals at the Oyster Creek site are to improve habitat for marsh wren, seaside sparrow, sharp-tailed sparrows, and other marsh-nesting species and to improve habitat for diamondback terrapin in the open sand area at the western end of the site. As indicated in Table 5-17, alternative plans involve providing a meandering and braided channel system to introduce tidal water to: (1) the areas dominated by phragmites and (2) the perimeter ditches and interior fresh water depressions. The plans are differentiated by the amount of channel excavation and corresponding areas of tidal marsh restoration. Areas dominated by phragmites will be cleared by burning and herbicide application.

TABLE 5-17
OUTPUTS OF ALTERNATIVE RESTORATION PLANS
OYSTER CREEK

Alternative Restoration Plans	Restoration Features	Restoration Outputs* Tidal Marsh & Diamondback Terrapin Habitat (acres)
Alternative 1 (No Action)	n.a.	n.a.
Alternative 2	open meandering channel: 2,000 feet long; 80 feet wide at MLW	19.37 (tidal marsh- 9.23) (terrapin – 10.14)
Alternative 3	open meandering channel: 9,400 feet long; 35 feet wide at MLW	28.45 (tidal marsh- 18.31) (terrapin – 10.14)
Alternative 4	open meandering channel: 15,900 feet long; 35 feet wide at MLW	35.00 (tidal marsh- 24.86) (terrapin – 10.14)

* Additional ecological outputs directly resulting from restoration action

The total average annual costs of the Oyster Creek alternative plans are presented in Table 5-18. These costs are based on average annual implementation costs and annual OMRR&R costs. Average annual implementation costs include capital costs, real estate costs, and interest during construction.

The average costs of the Oyster Creek alternative plans in dollars per acre are presented in Table 5-19. As illustrated in Figure 5-37, the CEA determined that all of the alternative plans for Oyster Creek are cost effective. Consequently, the three plans (and the No Action alternative) were carried forward to the ICA.

TABLE 5-18
COSTS OF ALTERNATIVE RESTORATION PLANS
OYSTER CREEK

Alternative Restoration Plans	Implementation Costs			OMRR&R Costs	Total Average Annual Costs
	Total Project First Cost	Interest During Construction	Average Annual Equivalent Cost**		
Alternative 1 (No Action)	$0	$0	$0	$0	$0
Alternative 2	$892,800	$8,904	$71,400	$3,200	$74,600
Alternative 3	$1,934,600	$29,037	$155,400	$3,200	$158,600
Alternative 4	$3,040,800	$68,804	$246,200	$3,200	$249,400

* Includes construction and real estate costs
** 25 years at 6.125 percent

TABLE 5-19
AVERAGE COSTS OF ALTERNATIVE RESTORATION PLANS
OYSTER CREEK

Alternative Restoration Plans*	Outputs (acres)	Average Annual Costs ($)	Average Cost ($/acre)
Alternative 1 (No Action)	0	$0	$0
Alternative 2	19.37	$74,600	$3,850
Alternative 3	28.45	$158,600	$5,580
Alternative 4	35.00	$249,400	$7,130

* Plans ranked by output

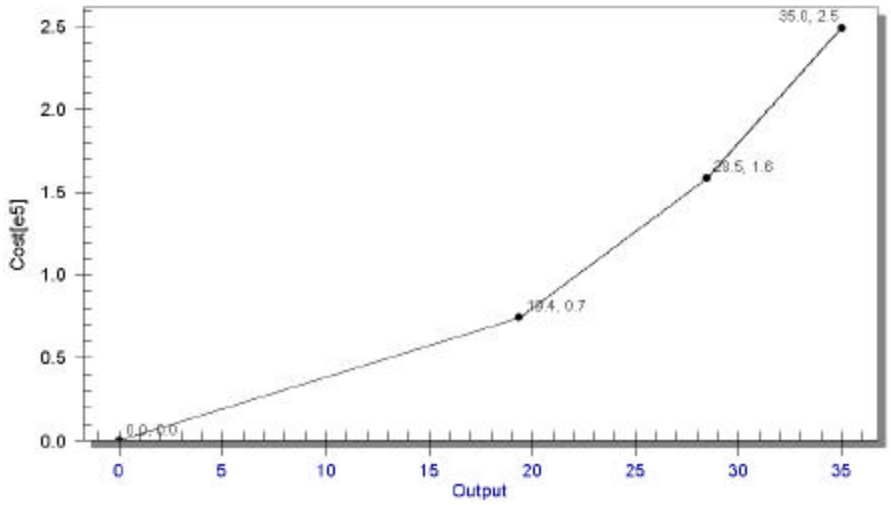


Figure 5-37. Oyster Creek – Cost Effective Plans

The results of ICA for Oyster Creek are presented in Table 5-20 and illustrated in Figure 5-38. This table includes the incremental cost and incremental output of the alternatives identified by the ICA as Best Buy plans. As indicated in this table, all three alternative restoration plans were identified by the ICA as being Best Buy plans for Oyster Creek ecosystem restoration.

TABLE 5-20
BEST BUY RESTORATION PLANS
OYSTER CREEK

Alternative Restoration Plans*	Outputs (acres)	Average Annual Costs ($)	Average Cost ($/acre)	Incremental Costs ($)	Incremental Output (acres)	Incremental Cost per Output ($/acre)
Alternative 2	19.37	$74,600	$3,850	$74,600	19.37	$3,850
Alternative 3	28.45	$158,600	$5,580	$84,000	9.08	$9,250
Alternative 4	35.00	$249,400	$7,130	$90,800	6.55	$13,860

* Plans ranked by output

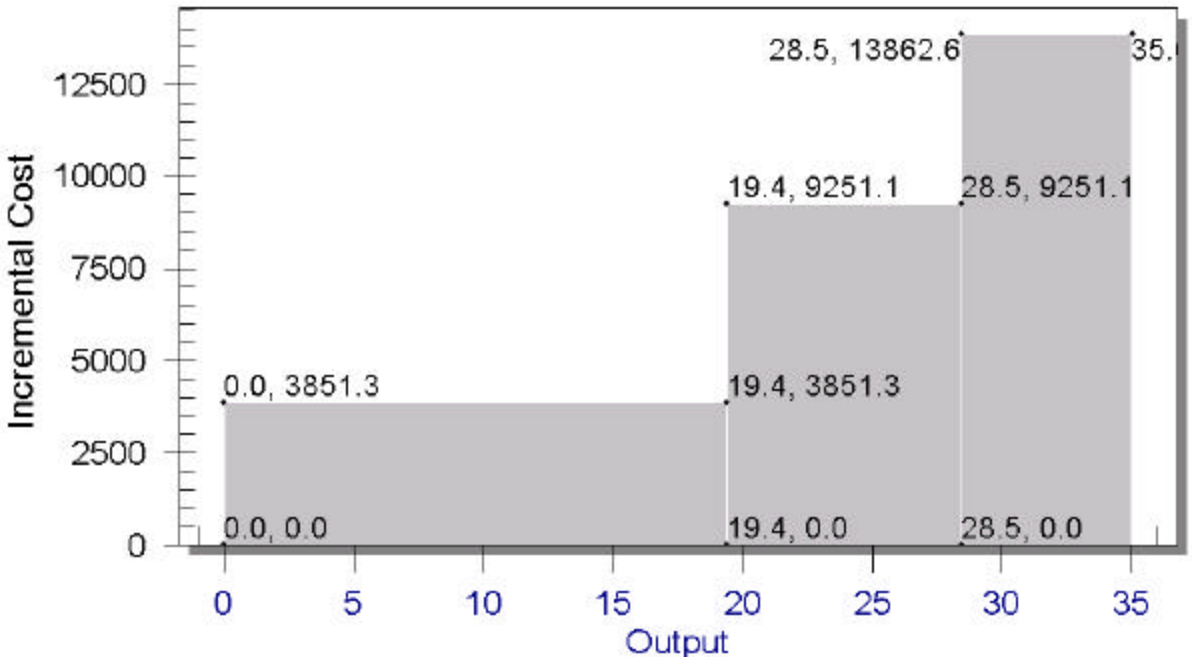


Figure 5-38. Oyster Creek – Best Buy Plans

5.4.4.7 Barnegat Lighthouse

The alternative plans formulated for the Barnegat Lighthouse site are profiled in Table 5-21. The restoration goal of this project is to improve shorebird habitat, specifically for piping plover. The alternative plans include creation of habitat consisting of a shallow pond with access to tidal water with one or two inlets provided by either open channels or culverts.

TABLE 5-21
OUTPUTS OF ALTERNATIVE RESTORATION PLANS
BARNEGAT LIGHTHOUSE

Alternative Restoration Plans	Restoration Features	Restoration Outputs* Piping Plover Habitat (acres)
Alternative 1 (No Action)	n.a.	n.a.
Alternative 2A	5-acre excavated pond with access by open channel	6.40
Alternative 2B	5-acre excavated pond with access by culvert system	6.23
Alternative 3A	2-acre excavated pond with access by open channel	2.95
Alternative 3B	2-acre excavated pond with access by culvert system	2.77
Alternative 4A	5-acre excavated pond with access by 2 open channels	6.72
Alternative 4B	5-acre excavated pond with access by 2 culvert systems	6.23
Alternative 5A	2-acre excavated pond with access by 2 open channels	3.36
Alternative 5B	2-acre excavated pond with access by 2 culvert systems	2.77

* Additional ecological outputs directly resulting from restoration action

The total average annual costs of the Barnegat Lighthouse alternative plans are presented in Table 5-22. These costs are based on average annual implementation costs and annual OMRR&R costs. Average annual implementation costs include capital costs, real estate costs, and interest during construction.

The average costs of the Barnegat Lighthouse alternative plans in dollars per acre are presented in Table 5-23. The results of the CEA for Barnegat Lighthouse are also presented in Table 5-23 and illustrated in Figure 5-39. The CEA eliminated Alternative 3B, Alternative 5B, Alternative 2B, and Alternative 4B, since their levels of output could be more efficiently achieved by other plans. Consequently, Alternative 3A, Alternative 5A, Alternative 2A, and Alternative 4A (and the No Action alternative) were carried forward to the ICA.

TABLE 5-22
COSTS OF ALTERNATIVE PLANS
BARNEGAT LIGHTHOUSE

Alternative Restoration Plans	Implementation Costs			OMRR&R Costs	Total Average Annual Costs
	Total Project First Cost	Interest During Construction	Average Annual Equivalent Cost**		
Alternative 1 (No Action)	$0	$0	$0	$0	$0
Alternative 2A	$1,613,600	$24,219	$223,800	$2,800	$226,600
Alternative 2B	$1,615,100	$24,241	$224,000	$2,800	$226,800
Alternative 3A	$790,000	$11,857	$109,600	$2,800	$112,400
Alternative 3B	$797,900	$11,976	$110,700	$2,800	$113,500
Alternative 4A	$1,751,500	$26,289	$243,000	$2,800	$245,800
Alternative 4B	$1,771,900	$26,595	$245,800	$2,800	$248,600
Alternative 5A	$945,100	$14,185	$131,100	$2,800	$133,900
Alternative 5B	$955,900	$14,347	$132,600	$2,800	$135,400

* Includes construction and real estate costs
** 10 years at 6.125 percent

TABLE 5-23
AVERAGE COSTS OF ALTERNATIVE PLANS
BARNEGAT LIGHTHOUSE

Alternative Restoration Plans*	Outputs (acres)	Average Annual Costs ($)	Average Cost ($/acre)
Alternative 1 (No Action)	0	$0	$0
Alternative 3B**	2.77	$113,500	$40,970
Alternative 5B**	2.77	$135,400	$48,880
Alternative 3A	2.95	$112,400	$38,100
Alternative 5A	3.36	$133,900	$39,850
Alternative 2B**	6.23	$226,800	$36,400
Alternative 4B**	6.23	$248,600	$39,900
Alternative 2A	6.40	$226,600	$35,410
Alternative 4A	6.72	$245,800	$36,580

* Plans ranked by output
** Eliminated by CEA

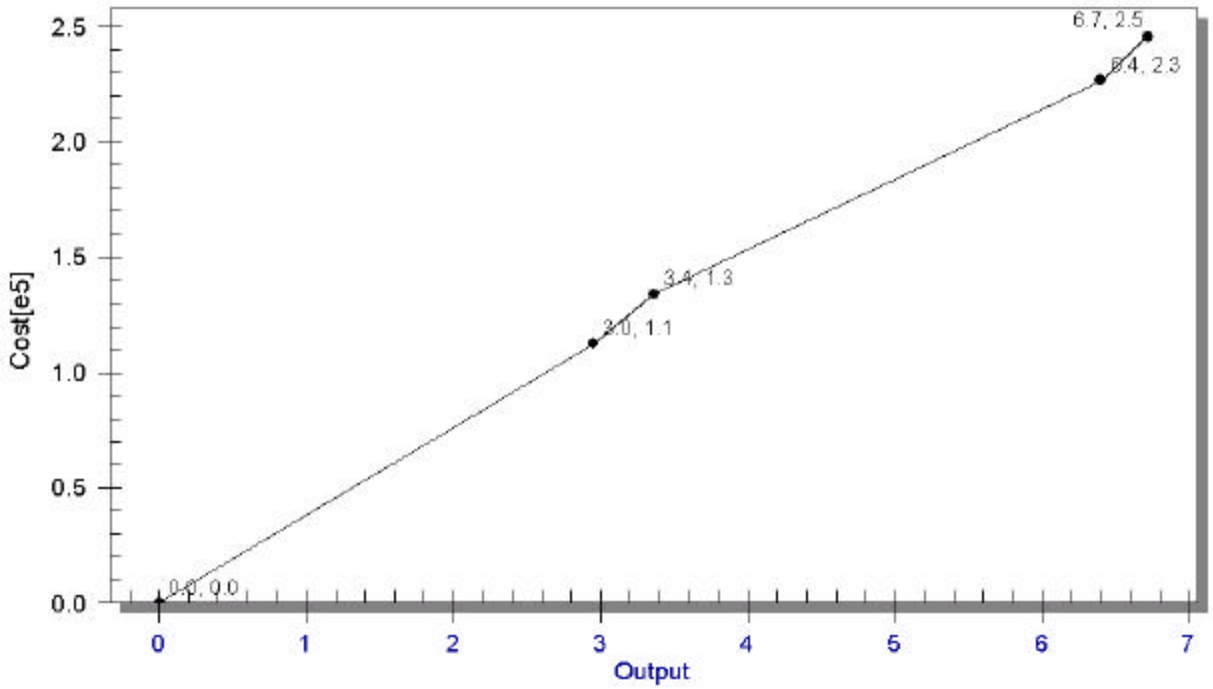


Figure 5-39. Barnegat Lighthouse – Cost Effective Plans

The results of ICA for Barnegat Lighthouse are presented in Table 5-24 and illustrated in Figure 5-40. This table includes the incremental cost and incremental output of the alternatives identified by the ICA as Best Buy plans. As indicated in this table, Alternative 2A and Alternative 4A were identified by the ICA as being Best Buy plans for Barnegat Lighthouse.

5.4.4.8 Stafford Forge

The alternative plans formulated for the Stafford Forge site are profiled in Table 5-25. The restoration goals for this site are to create habitat for alewife and blueback herring and to improve habitat for waterfowl, including black duck and egret. The seven alternative plans include various combinations of (1) fish passage and refurbished water control structures to provide fish access to upstream waters (2) water control structures installed to reduce depths in the ponds to improve habitat for waterfowl, including black duck and egret. As indicated in Table 5-25, the outputs of the alternative plans for Stafford Forge are expressed in acres of anadromous fish habitat and black duck habitat.

TABLE 5-24
BEST BUY PLANS
BARNEGAT LIGHTHOUSE

Alternative Restoration Plans*	Outputs (acres)	Average Annual Costs ($)	Average Cost ($/acre)	Incremental Costs ($)	Incremental Output (acres)	Incremental Cost per Output ($/acre)
Alternative 2A	6.40	$226,600	$35,400	$226,600	6.40	$35,400
Alternative 4A	6.72	$245,800	$36,580	$19,200	0.32	$60,000

* Plans ranked by output

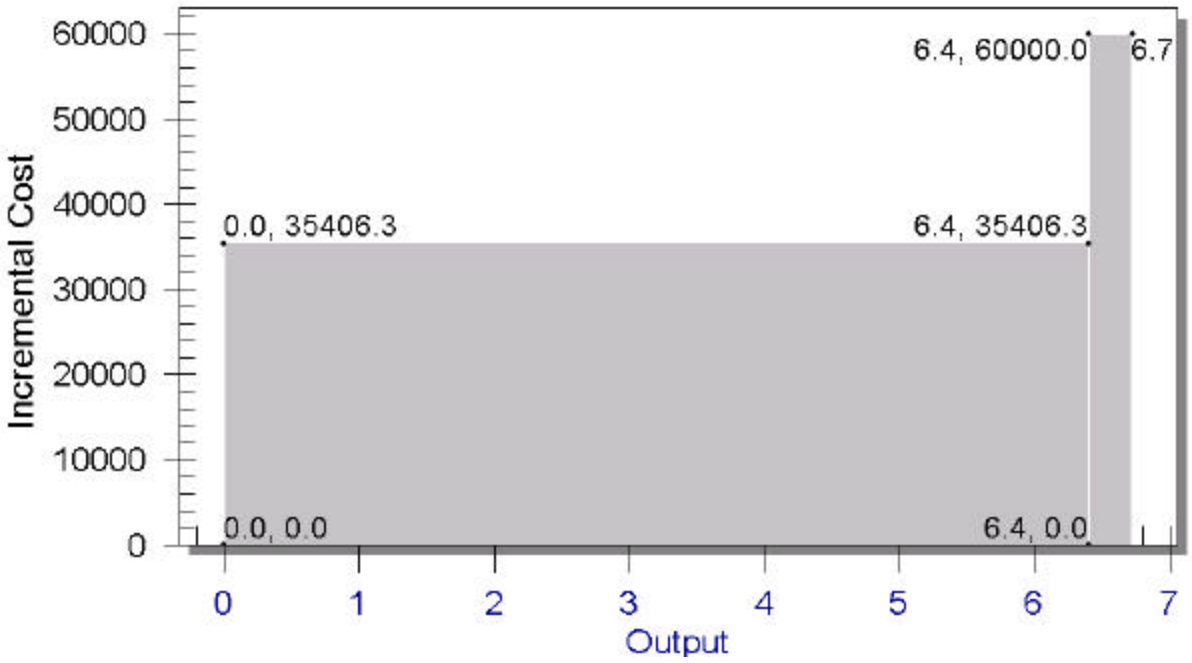


Figure 5-40. Barnegat Lighthouse – Best Buy Plans

TABLE 5-25
OUTPUTS OF ALTERNATIVE RESTORATION PLANS
STAFFORD FORGE

Alternative Restoration Plans	Restoration Features	Restoration Outputs* Anadromous Fishery & Black Duck Habitat (Emergent Marsh) in acres
Alternative 1 (No Action)	n.a.	n.a.
Alternative 2	Fish ladder and 54-acre shallow pond and stream bed	56.28 (anadromous fishery – 56.28)
Alternative 3	In addition to Alternative 2: improved fish passage and 14 acres of shallow pond and stream bed	62.94 (anadromous fishery – 62.94)
Alternative 4	In addition to Alternative 3: 44 acres of shallow pond and stream bed	113.57 (anadromous fishery – 113.57)
Alternative 5	In addition to Alternative 2: 3 water control structures at Ponds 2, 3, and 4	127.14 (anadromous fishery – 56.28) (black duck – 70.86)
Alternative 6	In addition to Alternative 3: 3 water control structures at Ponds 2, 3, and 4	133.80 (anadromous fishery – 62.94) (black duck – 70.86)
Alternative 7	In addition to Alternative 4: 3 water control structures at Ponds 2, 3, and 4	184.43 (anadromous fishery – 113.57) (black duck – 70.86)
Alternative 8	3 water control structures at Ponds 2, 3, and 4	70.86 (black duck – 70.86)

* Additional ecological outputs directly resulting from restoration action

The total average annual costs of the Stafford Forge alternative plans are presented in Table 5-26. These costs are based on average annual implementation costs and annual OMRR&R costs. Average annual implementation costs include capital costs, real estate costs, and interest during construction.

The results of the CEA for Stafford Forge are presented in Table 5-27 and illustrated in Figure 5-41. The alternatives are ranked according to their output levels (in acres). The table includes average costs per acre of the Stafford Forge alternative plans. The CEA determined that some of the alternative plans are not cost effective. Specifically, Alternative 2 and Alternative 3 were eliminated, since their output levels could be achieved more efficiently by Alternative 8. The remaining Stafford Forge plans (and the No Action alternative) were carried forward to the ICA.

TABLE 5-26
COSTS OF ALTERNATIVE PLANS
STAFFORD FORGE

Alternative Restoration Plans	Implementation Costs			OMRR&R Costs	Total Average Annual Costs
	Total Project First Cost	Interest During Construction	Average Annual Equivalent Cost**		
Alternative 1 (No Action)	$0	$0	$0	$0	$0
Alternative 2	$134,600	$2,020	$10,800	$500	$11,300
Alternative 3	$153,100	$2,298	$12,300	$500	$12,800
Alternative 4	$182,700	$2,742	$14,700	$500	$15,200
Altemative 5	$202,300	$3,036	$16,300	$500	$16,800
Alternative 6	$220,300	$3,307	$17,700	$500	$18,200
Alternative 7	$250,000	$3,752	$20,100	$500	$20,600
Alternative 8	$87,600	$1,315	$7,000	$500	$7,500

* Includes construction and real estate costs
** 25 years at 6.125 percent

TABLE 5-27
AVERAGE COSTS OF ALTERNATIVE RESTORATION PLANS
STAFFORD FORGE

Alternative Restoration Plans*	Outputs (acres)	Average Annual Costs ($)	Average Cost ($/acre)
Alternative 1 (No Action)	0	$0	$0
Alternative 2**	56.28	$11,300	$200
Alternative 3**	62.94	$12,800	$200
Alternative 8	70.86	$7,500	$106
Alternative 4	113.57	$15,200	$130
Alternative 5	127.14	$16,800	$130
Alternative 6	133.80	$18,200	$140
Alternative 7	184.43	$20,600	$112

* Plans ranked by output
** Eliminated by CEA

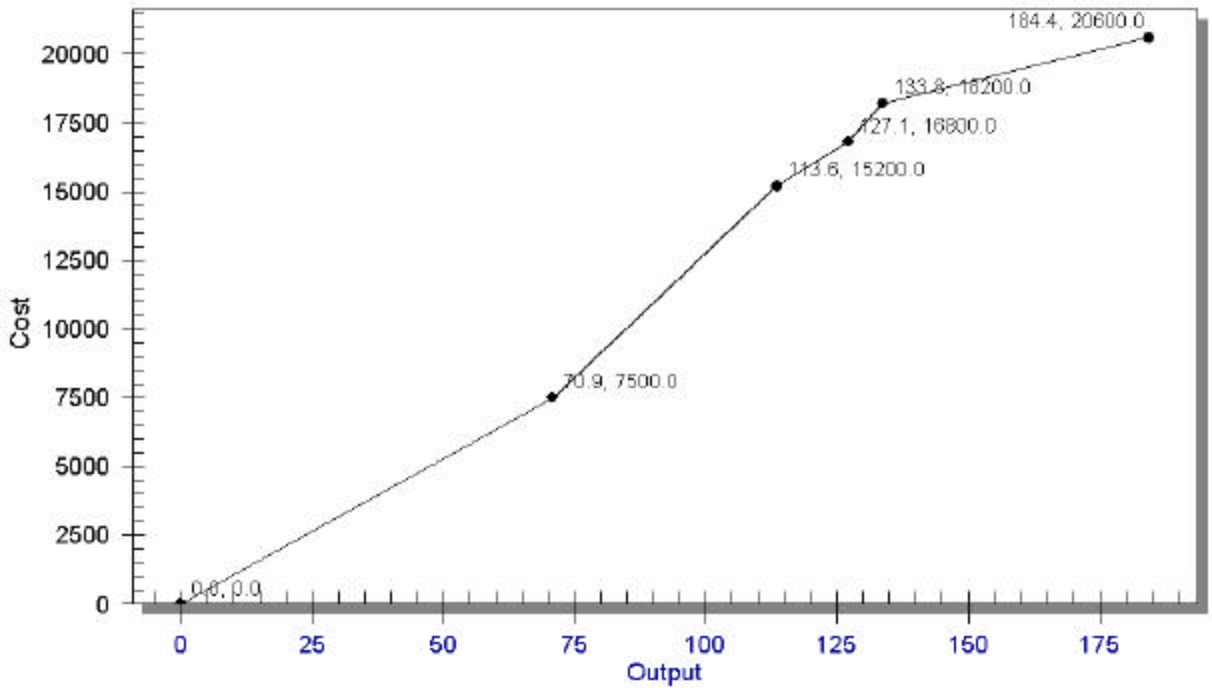


Figure 5-41. Stafford Forge – Cost Effective Plans

The results of ICA for Stafford Forge are presented in Table 5-28 and illustrated in Figure 5-42. This table includes the incremental cost and incremental output of the alternatives identified by the ICA as Best Buy plans. As indicated in this table and in the figure, Alternative 8 and Alternative 7 were identified by the ICA as being Best Buy plans for Stafford Forge.

TABLE 5-28
BEST BUY RESTORATION PLANS
STAFFORD FORGE

Alternative Restoration Plans*	Outputs (acres)	Average Annual Costs ($)	Average Cost ($/acre)	Incremental Costs ($)	Incremental Output (acres)	Incremental Cost per Output ($/acre)
Alternative 8	70.86	$7,500	$106	$7,500	70.86	$106
Alternative 7	184.43	$20,600	$112	$13,100	113.57	$115

* Plans ranked by output

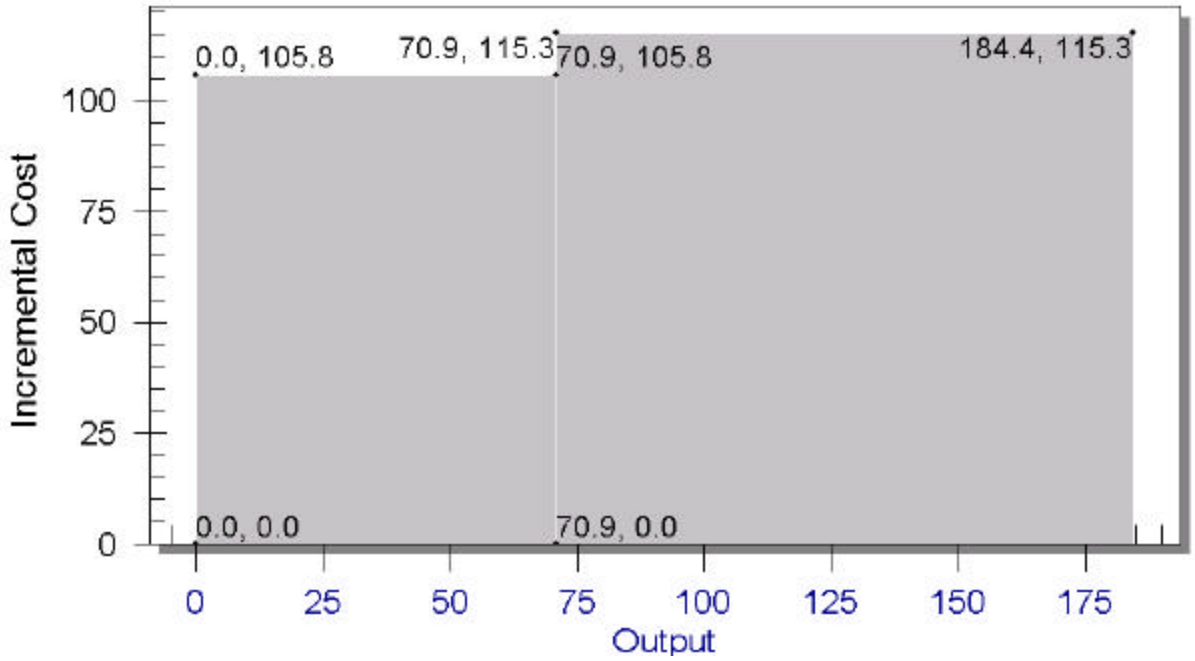


Figure 5-42. Stafford Forge – Best Buy Plans

5.4.4.9 Flat Island

The alternative plans formulated for the Flat Island site are profiled in Table 5-29. The restoration goals at this site are to improve habitat for marsh wren, seaside sparrow, sharp-tailed sparrow, and other marsh-nesting species. The restoration alternatives consist of excavating a meandering and braided channel system connecting to the Bay at one or more locations along the western and northwestern sides of the island. Areas dominated by phragmites will be cleared by herbicide spraying and subsequent burning. The eastern and northeastern portions of the island were not considered for restoration due to their potential use as a dredged material disposal site.

TABLE 5-29
OUTPUTS OF ALTERNATIVE RESTORATION PLANS
FLAT ISLAND

Alternative Restoration Plans	Restoration Features	Restoration Outputs* Tidal Marsh (acres)
Alternative 1 (No Action)	n.a.	n.a.
Alternative 2	open meandering channel: 13,000 feet long; 70 feet wide at MLW	13.36
Alternative 3	open meandering channel: 10,000 feet long; 70 feet wide at MLW	10.08
Alternative 4	open meandering channel: 5,000 feet long; 70 feet wide at MLW	5.3

* Additional ecological outputs directly resulting from restoration action

The total average annual costs of the Flat Island alternative plans are presented in Table 5-30. These costs are based on average annual implementation costs and annual OMRR&R costs. Average annual implementation costs include capital costs, real estate costs, and interest during construction.

TABLE 5-30
COSTS OF ALTERNATIVE RESTORATION PLANS
FLAT ISLAND

Alternative Restoration Plans	Implementation Costs			OMRR&R Costs	Total Average Annual Costs
	Total Project First Cost	Interest During Construction	Average Annual Equivalent Cost**		
Alternative 1 (No Action)	$0	$0	$0	$0	$0
Alternative 2	$2,465,800	$55,793	$199,600	$5,400	$205,000
Alternative 3	$1,883,200	$28,265	$151,300	$3,200	$154,500
Alternative 4	$1,096,600	$10,936	$87,700	$3,200	$90,900

* Includes construction and real estate costs
** 25 years at 6.125 percent

The average costs of the Flat Island alternative plans in dollars per acre are presented in Table 5-31. As illustrated in Figure 5-43, the CEA determined that all of the alternative plans for Flat Island are cost effective. Consequently, the three plans (and the No Action alternative) were carried forward to the ICA.

TABLE 5-31
AVERAGE COSTS OF ALTERNATIVE RESTORATION PLANS
FLAT ISLAND

Alternative Restoration Plans*	Outputs (acres)	Average Annual Costs ($)	Average Cost ($/acre)
Alternative 1 (No Action)	0	$0	$0
Alternative 4	5.3	$90,900	$17,150
Alternative 3	10.08	$154,500	$15,330
Alternative 2	13.36	$205,000	$15,340

* Plans ranked by output

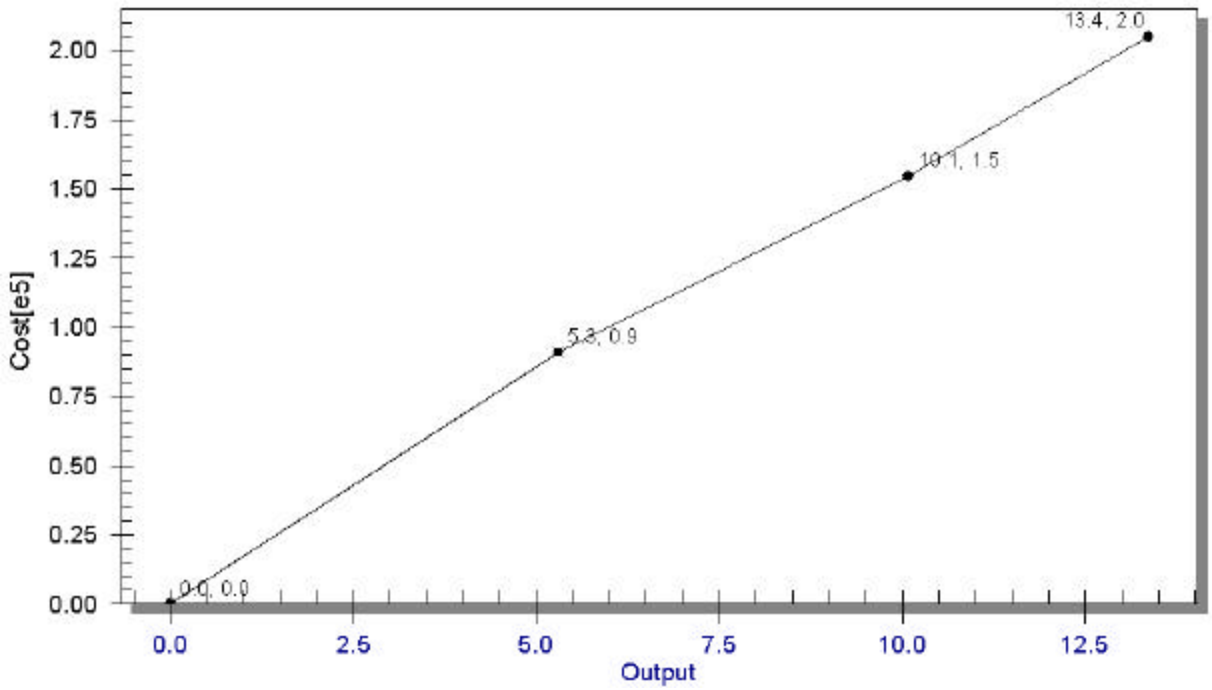


Figure 5-43. Flat Island – Cost Effective Plans

The results of ICA for Flat Island are presented in Table 5-32 and illustrated in Figure5-44. The table includes the incremental cost and incremental output of the alternatives identified by the ICA as Best Buy plans. As indicated in the table and figure, Alternative 3 and Alternative 2 were identified by ICA as being Best Buy plans for Flat Island ecosystem restoration.

TABLE 5-32
BEST BUY RESTORATION PLANS
FLAT ISLAND

Alternative Restoration Plans*	Outputs (acres)	Average Annual Costs ($)	Average Cost ($/acre)	Incremental Costs ($)	Incremental Output (acres)	Incremental Cost per Output ($/acre)
Alternative 3	10.08	$154,500	$15,330	$154,500	10.08	$15,330
Alternative 2	13.36	$205,000	$15,340	$50,500	3.28	$15,400

* Plans ranked by output

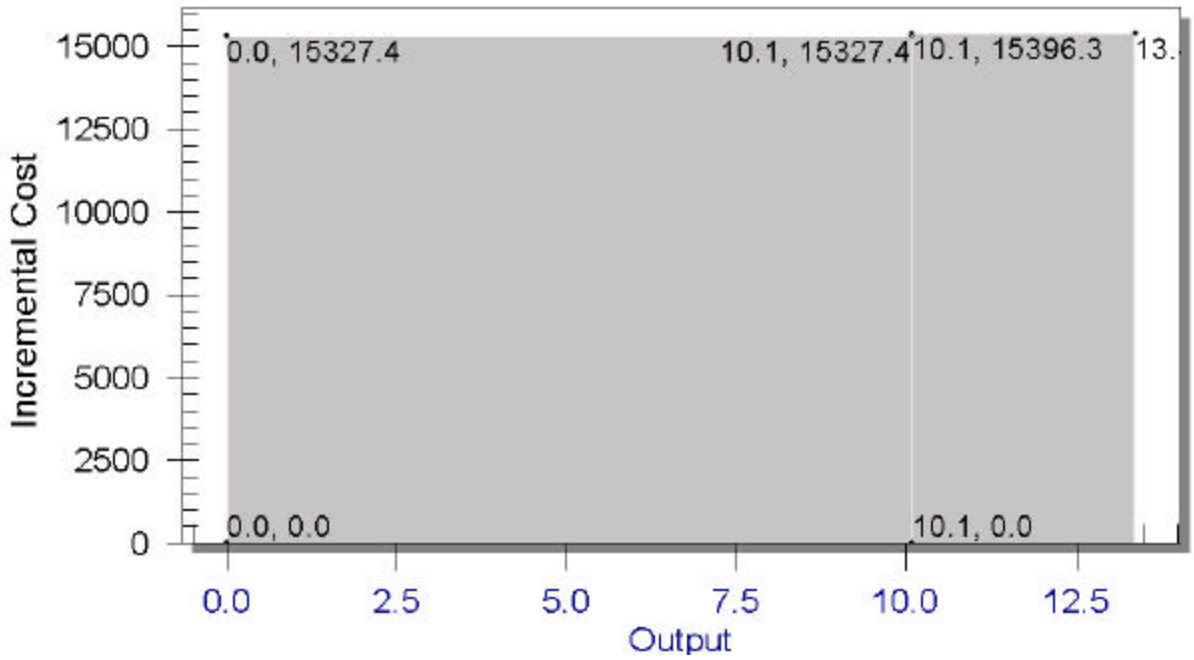


Figure 5-44. Flat Island – Best Buy Plans

5.4.4.10 Conclusion

The CE/ICA conducted in this investigation of ecosystem restoration in Barnegat Bay has identified "Best Buy" restoration plans for the six Barnegat Bay sites (see Table 5-33). These plans would have the lowest unit costs for a variety of restoration levels at each site.

5.4.4.11 Discussion

The selection of the recommended restoration plan for a given site can be a complex undertaking. The comparison of incremental costs and incremental outputs provides a way to evaluate alternative levels of ecosystem restoration. CE/ICA shows what additional costs would be incurred and what additional outputs would be gained if successively larger plans were implemented. The analyses do not specify whether one Best Buy plan is preferable to another. Decision makers must decide whether the additional output provided by each successive output level is worth its additional cost.

USACE planning guidance does not require selection of a Best Buy alternative as the recommended restoration plan. In the case of Barnegat Bay, a variety of considerations outside of the CE/ICA may influence plan selection. Such considerations may include preferences of the non-Federal project partner, effects on threatened or endangered species, or input from Federal or state resource agencies. These considerations may favor one Best Buy plan over another or a plan not identified as a Best Buy plan over one that is.

TABLE 5-33
SUMMARY OF
BEST BUY RESTORATION PLANS
BARNEGAT BAY

Alternative Restoration Plans*	Outputs (acres)	Average Annual Costs ($)	Average Cost ($/acre)	Incremental Costs ($)	Incremental Output (acres)	Incremental Cost per Output ($/acre)
F&L Abandoned Lagoons						
Alternative 3	11.72	$68,000	$5,800	$68,000	11.72	$5,800
Bayville Abandoned Lagoon						
Alternative 4	4.79	$55,900	$11,670	$55,900	4.79	$11,670
Oyster Creek						
Alternative 2	19.37	$74,600	$3,850	$74,600	19.37	$3,850
Alternative 3	28.45	$158,600	$5,580	$84,000	9.08	$9,250
Alternative 4	35	$249,400	$7,130	$90,800	6.55	$13,860
Barnegat Lighthouse						
Alternative 2A	6.4	$226,600	$35,400	$226,600	6.4	$35,400
Alternative 4A	6.72	$245,800	$36,580	$19,200	0.32	$60,000
Stafford Forge						
Alternative 8	70.86	$7,500	$106	$7,500	70.86	$106
Alternative 7	184.43	$20,600	$112	$13,100	113.57	$115
Flat Island						
Alternative 3	10.08	$154,500	$15,330	$154,500	10.08	$15,330
Alternative 2	13.36	$205,000	$15,340	$50,500	3.28	$15,400

6.0 DESCRIPTION AND EVALUATION OF SELECTED PLANS

The plan formulation process culminates in the identification of the selected plans for the Barnegat Bay Ecosystem Restoration Feasibility Study. The first subsection in this chapter identifies the selected alternative plans for each of the six restoration sites and describes the decision criteria used in the selection. The second subsection describes the selected plan, including the selected alternative at each site, in detail. The third subsection compares the with- and without-project conditions at each site, while the fourth and longest subsection evaluates the potential environmental effects of implementing the selected plans. All potential affected natural and socioeconomic resources are considered in this section, consistent with NEPA requirements. The fifth and last subsection provides a project cost estimate that addresses the selected plans at each site.

6.1 IDENTIFICATION OF THE SELECTED PLANS

A number of alternative plans were formulated for each of the six Barnegat Bay ecosystem restoration project sites. These alternatives were fully described in Section 5, including calculation of habitat units to be created by each alternative. Subsequently, each alternative for the six project sites was evaluated through cost effectiveness and incremental cost analyses (CE/ICA): the results of the CE/ICA were also presented in Section 5. Because the CE/ICA results inform, but do not determine, the final plan selection, additional feasibility factors (e.g., competing sites needs, logistical constraints, and project sustainability) were considered along with the technical and cost information to select the best alternative plan for each restoration site. The subsections below identify the selected plan for each site and describe the decision criteria used in its selection.

6.1.1 F&L Abandoned Lagoons

Alternative 3 is the selected plan. This alternative would maximize new habitats for juvenile fish, benthic invertebrates, and diamondback terrapin at the lowest average cost per acre (refer to Section 5.4.5); it is the only best buy identified for this site. Alternative 3 would provide a total of 8.45 acres of fish and benthic habitat and 3.27 acres of diamondback terrapin habitat. The project goals would be realized through a combination of decreasing existing lagoon depths to an average of 6 feet, improving water quality (by improving circulation and decreasing depth), and flattening/clearing existing sandy piles (for terrapin habitat). The 6-foot average depth would likely provide for SAV growth with its attendant benefits for fish and wildlife habitat, and for water quality. Two separate parcels of ideal terrapin habitat would be created; both would be completely isolated from predators by substantial waterways. The alternative would supply the best circulation (and greatest improvement in water quality) of all the alternatives without deepening the very shallow entrance channel to the L Lagoon. The slight increase in circulation that would result from deepening the entrance channel to the L Lagoon in Alternative 5 would have potentially significant negative consequences on the adjacent tidal wetlands.

6.1.2 Bayville Abandoned Lagoon

Alternative 4 is the selected plan. This alternative would maximize new habitats for juvenile fish, benthic invertebrates, and black duck (refer to Section 5.4.5); it is one of two best buys for this site. Alternative 4 would provide a total of 4.79 acres of fish and benthic and black duck habitat. This alternative has the lowest cost per acre, and has the best access for construction. It is also the only alternative that does not interfere with the existing spur road. The project goals would be realized through a combination of decreasing existing lagoon depths to an average of 6 feet, improving water quality (by improving circulation and decreasing depth). The 6-foot average depth would likely provide for SAV growth with its attendant benefits for fish and wildlife habitat, and for water quality. The new SAV habitat would be add to the existing SAV habitat in the shallow area of the lagoon, an area valuable to black ducks and other dabbling waterfowl. The other best buy, Alternative 2, would produce less new habitat (4.43 acres) at a higher cost per acre. While Alternative 3 would provide a nearly identical quantity of new habitat (4.68 acres), it is not a best buy, nor would it provide Alternative 4's secondary benefit of directly converting about 0.21 acre more of the existing phragmites marsh to new tidal marsh habitat and open water. The existing phragmites marsh habitats are large and of relatively poor habitat quality. Alternative 4 makes use of an existing geographically low area and converts some phragmites marsh. In addition, Alternative 4 would require conversion of about 0.09 acre less existing upland deciduous forest than Alternative 3. Unlike the other alternatives, Alternative 4 would not leave a circulatory dead end in the lagoon, thus providing better flushing.

6.1.3 Oyster Creek

Alternative 3 is the selected plan. This alternative would produce substantial new tidal marsh habitat for a suite of songbirds (marsh wren, sharp-tailed sparrow, seaside sparrow, etc.), and other wildlife, as well as improve an open sandy area for diamondback terrapin (refer to Section 5.4.5); it is one of three best buys for this site. Alternative 3 would provide a total of 18.31 acres of new tidal marsh habitats for songbirds and 10.14 acres of new open sandy habitats for diamondback terrapins. The project goals would be realized by opening the site to tidal, saline Bay water through a system of open, meandering channels. All of the channels would be cut primarily through dense, nontidal phragmites marsh, and would incorporate the existing system of small, shallow ponds and ditches. Clean, sandy materials excavated from the channels would be deposited on the existing semi-open sandy area and adjacent upland phragmites habitats. Alternative 3 represents a middle ground between the other best buy alternatives, both in terms of habitats provided and in average cost per acre. The cost per acre difference between Alternatives 3 and 4 is similar to the cost per acre difference between Alternatives 2 and 3, but Alternative 3 provides better habitat quality. Alternative 3 also retains area for possible future dredged disposal that may be required by the landowner. The network of channels included in Alternative 3 are more likely to produce natural hydrological patterns than the lower average cost Alternative 2. Alternative 2 introduces tidal flow to ponds, but has limited impact on phragmites, which therefore limits wetland restoration.

6.1.4 Barnegat Lighthouse

Alternative 4A is the selected plan. This alternative would maximize new habitats for an existing breeding population of piping plover, listed as a Federal threatened species; the project would also likely benefit other state-listed birds such as least tern (New Jersey-listed as endangered) and other uncommon or rare bird species (refer to Section 5.4.5); and it is one of two best buys for this site. Alternative 4A would provide approximately 6.72 acres of new shallow intertidal pond habitat with two open entrance channels. The proposed location for the new intertidal pond represents an ideal physical situation for maximizing use by the resident breeding piping plovers; it provides a large amount of surface area for feeding adjacent to the existing nesting sites. While the other best buy, Alternative 2A, would provide approximately the same amount of habitat (slightly less, at 6.40 acres), it would possess only one open entrance channel, leaving it more susceptible to loss of tidal flow as a result of storms. The two open channels created for Alternative 4A, however, would also require two access bridge structures instead of one for Alternative 2A. Although the immediate costs for Alternative 4A would be slightly greater, maintenance would not increase significantly, and the sustainability of the project would be substantially enhanced.

6.1.5 Stafford Forge

Alternative 7 is the selected plan. This alternative would maximize passage of anadromous and catadromous fishes (river herring and American eel, respectively) on Westecunk Creek at and above the Stafford Forge site, and would also convert several large off-stream open water ponds to more ecologically valuable vegetated emergent wetlands with interspersed small areas of open water (refer to Section 5.4.5); it is one of two best buys for the site. Alternative 7 would provide by far the largest quantity of new anadromous fish and black duck habitat of all the alternatives considered (more than double the amount of the other best buy, Alternative 8, which would not provide for fish passage). A total of 184.43 acres of on-site habitat would be created under Alternative 7; in addition, approximately 10.2 stream miles would be made available to fish on Westecunk Creek above Stafford Forge. The other alternatives which provide fish passage are much more expensive per acre.

6.1.6 Flat Island

Alternative 3 is the selected plan. This alternative would produce substantial new tidal marsh habitat for a suite of songbirds (marsh wren, sharp-tailed sparrow, seaside sparrow, etc.) and other wildlife (refer to Section 5.4.5); it is one of two best buys for the site. This alternative would provide approximately 10.08 acres of tidal marsh habitat at the lowest average cost per acre. The new habitat would be created by opening the site to tidal, saline Bay water through a system of open channels that would connect to existing tidal marsh. All of the channels would be cut through dense, nontidal phragmites marsh. The three restoration alternatives for Flat Island differ primarily in the complexity of their proposed channel systems. Alternative 3 represents a middle ground between the other alternatives; it provides significant, contiguous tidal marsh, while reserving a significant portion of the island for future dredged material disposal needs, and has the lowest incremental cost.

6.2 DETAILED DESCRIPTION OF SELECTED PLANS

The designs of the selected plans are consistent with accepted engineering practice for ecosystem restoration projects. Additional design work (i.e., Design Memorandum) will be required for some of the more complex components of some of the plans and plans and specifications will be required for all of the plans prior to construction. The following sections describe the selected plans in detail. Graphical details of the selected plans are shown in Figures 6-1 to 6-6.

6.2.1 F&L Abandoned Lagoons

The selected plan, shown in Figure 6-1, consists of excavating a 270-foot long channel of approximately 400 square feet in cross sectional area between the ends of the two prongs of F Lagoon, and two 200-foot long channels of approximately 400 square feet in cross sectional area between the ends of the two prongs of F Lagoon & L Lagoon, as well as filling both lagoons to an average depth of 6 feet and flattening/clearing existing sandy piles (for terrapin habitat). (See Figure 6-2.) The channel excavation quantity is 6,700 cubic yards. An additional 63,000 cubic yards will be required to fill the lagoons. Due to their already shallow depths, the existing shelves along the perimeters of both lagoons will not be included in this filling operation. Also, pilings will be installed at the new channel entrances from F Lagoon.

The two possible scenarios for construction access are as follows:

Access by Water: Due to the existence of high quality tidal marsh occupying the Barnegat Bay side of the L Lagoon, construction access by water would necessarily be from the F Lagoon side. Such a scenario would involve the following steps :

- Excavation of the connecting channel(s) between the F& L Lagoons with placement of the excavated material to raise the bottom elevations of the deeper lagoon sections.
- Hauling in by barge the deposition material from an off-site source or excavation of the berms around the L Lagoon.
- Completion of the deposition and grading work in the L Lagoon starting with the far east end and backing up towards the F Lagoon.
- Hauling in by barge the deposition material from an off-site source or excavation of the berms around the F Lagoon.
- Completion of the deposition work and grading work in the two prongs of the F Lagoon and backing up towards the entrance of the F Lagoon.

Access by Land: Trucking in the deposition material and construction equipment through the existing dirt roadbed that leads to the area between the F & L Lagoons, utilizing temporary geo-mats or equivalent material where necessary for base support.

For the construction of the channels connecting the two prongs of the F Lagoon and the F & L Lagoons, a long reach excavator(s) would typically be used as the primary equipment for excavation and for filling the lagoon from the landside.

It is envisioned that most, if not all, of the excavated material would be used on site for filling the lagoons to the specified 6-foot depth, including material that contains phragmites. It is

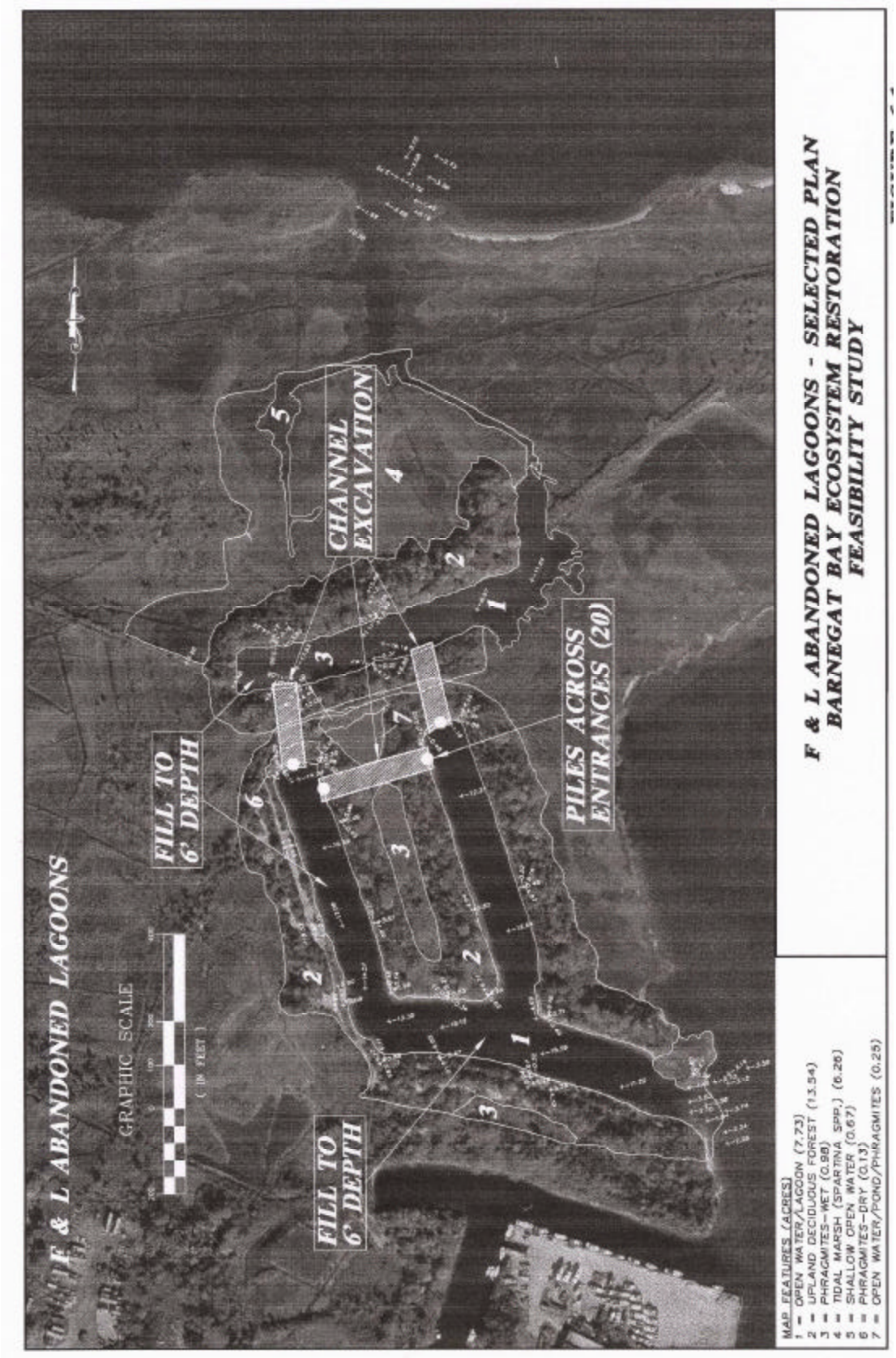
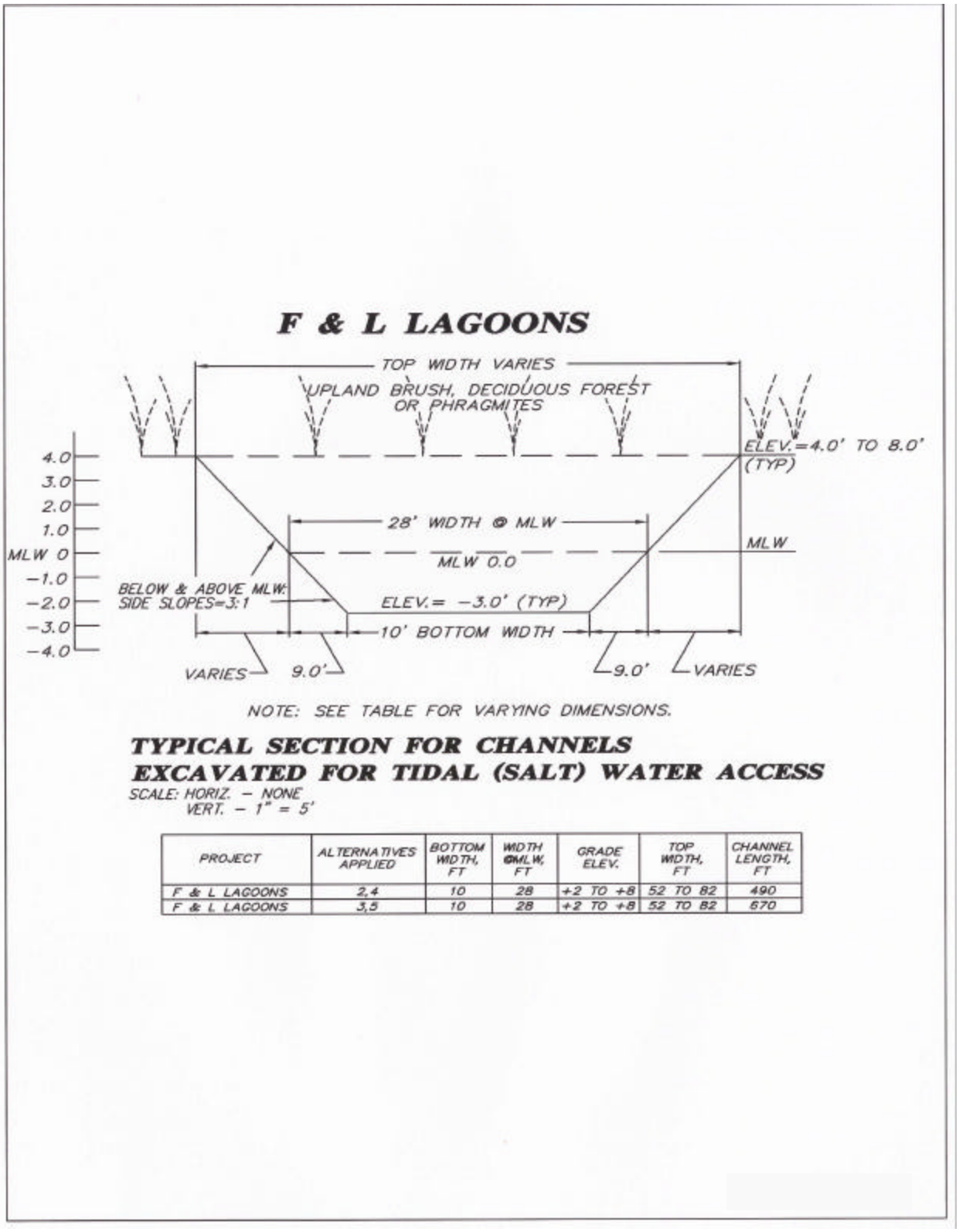


Figure 6-1 F&L ABANDONED LAGOONS-SELECTED PLAN



PROJECT	ALTERNATIVES APPLIED	BOTTOM WIDTH, FT	WIDTH @MLW, FT	GRADE ELEV.	TOP WIDTH, FT	CHANNEL LENGTH, FT
F & L LAGOONS	2,4	10	28	+2 TO +8	52 TO 82	490
F & L LAGOONS	3,5	10	28	+2 TO +8	52 TO 82	670

Figure 6-2 F&L LAGOONS-TYPICAL SECTION FOR CHANNELS EXCAVATED FOR TIDAL (SALT) WATER ACCESS

expected that exposure to tidal salt water would be lethal to phragmites rhizomes. However, trees, shrubs, and other portions of the excavated material that is designated as "unsuitable" for the purpose of filling the lagoon would be hauled offsite to an approved disposal site. The term "unsuitable material" refers to the portions of the excavated material that is not practical or otherwise suitable for filling the lagoons, for miscellaneous grading or other re-use on the site, due to such properties as high plasticity, high content of trees, shrubs and organic components. A final assessment regarding the suitability of the excavated material would be made during the construction phase.

Pilings will be installed at the entrances to the new connecting channels to deter public access through the excavated channel to the L Lagoon and the channel between the two prongs of the F Lagoon.

The following three options were considered for the material to be used to fill the F & L Lagoons:

- an offsite source to be identified, including any suitable material dredged from local channels in conjunction with public and private projects,
- the granular material forming the perimeter berms with vegetation that have been created during the original excavation of the lagoons (for the purposes of the feasibility study cost estimates, this source of fill material is selected), and
- the suitable portion of the material to be excavated to create the connecting channels on site.

6.2.2 Bayville Abandoned Lagoon

The selected plan, shown in Figure 6-3, consists of the excavation of an approximately 500-foot long channel with 300 square feet in cross section area meandering through the phragmites and tidal marsh areas between the west end of the lagoon and the Bay; installation of up to three 64"x43" elliptical concrete or aluminum corrugated metal arch (CMPA) culvert pipes with end sections, 50-foot long each across the road, and a 250-foot long open channel with 70 square feet of cross sectional area below MLW and up to 130 square feet above MLW through a short segment of the upland forest and predominantly phragmites area further to the east end of the Lagoon and into the Bay. (See Figures 6-4 and 6-5) In addition, raising the bottom elevation of the lagoon to an approximate depth of 6 feet is included. The channel excavation quantity is 5,700 cubic yards and the additional embankment excavation quantity required to fill the lagoons is 23,000 cubic yards.

Access by land and water will probably be required for this project as described below.

- Access from Bayville Avenue: A dirt road leads from Bayview Avenue along the east end of the lagoon towards south and west through the site, with an approximately 250-foot long branch providing access to the Bay. Field observations and AMA's limited supplementary surveys indicate that the road is 2 to 3 feet above the existing adjacent marsh, and has 20 to 30 feet of average width. Trucking in the deposition material and construction equipment through the existing dirt road that leads from

Bayville Avenue to the east and south sides of the lagoon, utilizing temporary geo-mats or equivalent material where necessary for base support is an option.

- Access by Water: It may be practical to consider access by water to the east side of the lagoon for both equipment access and the construction of the open channels and the culverts, as well as for hauling in from an off-site source the fill material required for raising the bottom of the lagoon. This is not the case for the west side of the lagoon, however. Because high quality tidal marsh patches exist among the phragmites occupying the area between the west side of the lagoon and Barnegat Bay, special care would be required in excavating the meandering open channel in this area, or in using this channel for hauling in the fill material to the lagoon.

For the construction of the channels connecting the lagoon with Barnegat Bay and for raising the bottom elevation of the lagoon, a long reach excavator(s) would typically be used as the primary equipment for excavation. This equipment would be used for filling the lagoon with material excavated from the existing berm area.

It is envisioned that all excavated material would be used in filling the lagoon to the specified 6-foot depth, including the material that contains phragmites. It is expected that exposure to tidal salt water would be lethal to phragmites rhizomes. Since there has been dumping on the site, the characteristics of the material to be excavated are not known. Trees, shrubs, and any other portion of the excavated material designated as "unsuitable" for the purposes of filling the lagoon would be hauled offsite to an approved disposal site. The term "unsuitable material" refers to the portions of the excavated material that is not practical or otherwise suitable for filling the lagoons, for miscellaneous grading or other re-use on the site, due to such properties as high plasticity, high content of trees, shrubs and organic components. A final assessment regarding the suitability of the excavated material would be made during the construction phase.

The following three options were considered for the material to be used to fill the Bayville Lagoon:

- an offsite source to be identified, including any suitable material dredged from local channels in conjunction with public and private projects,
- the granular material forming the perimeter berms with vegetation that were constructed during the original excavation of the lagoon (for the purposes of the feasibility study cost estimates, this source of fill material is selected), and
- the suitable portion of the material to be excavated to create the connecting channels on site.

Pilings will be installed at the entrance to the new western channel to block watercraft entrance to the lagoon after the channel is excavated. (The need for piles was recognized during the Cycle 5 Plan Formulation process. Therefore, they do not appear in the alternative plans identified during Cycle 4.)

Figure 6-3 BAYVILLE LAGOONS-SELECTED PLAN

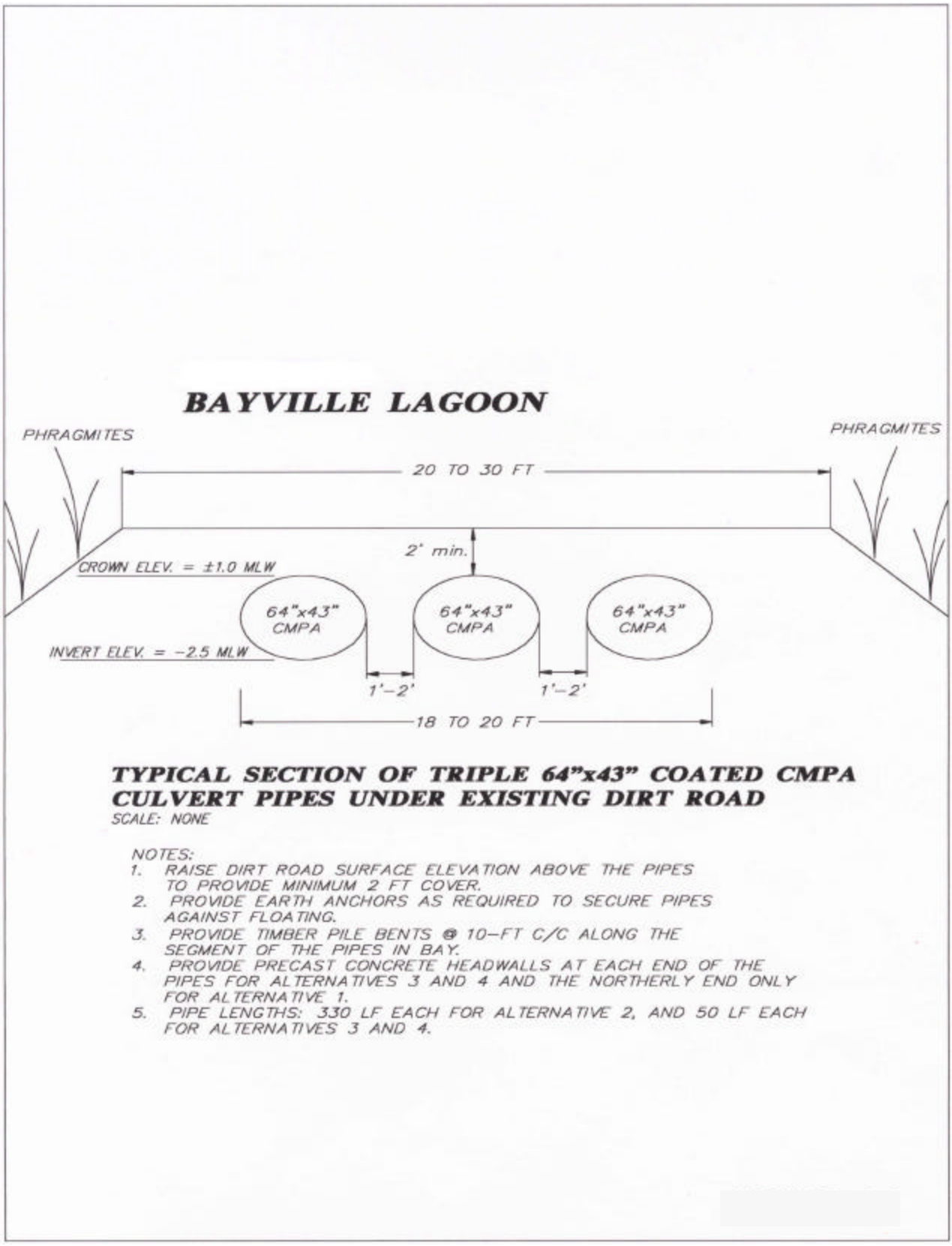
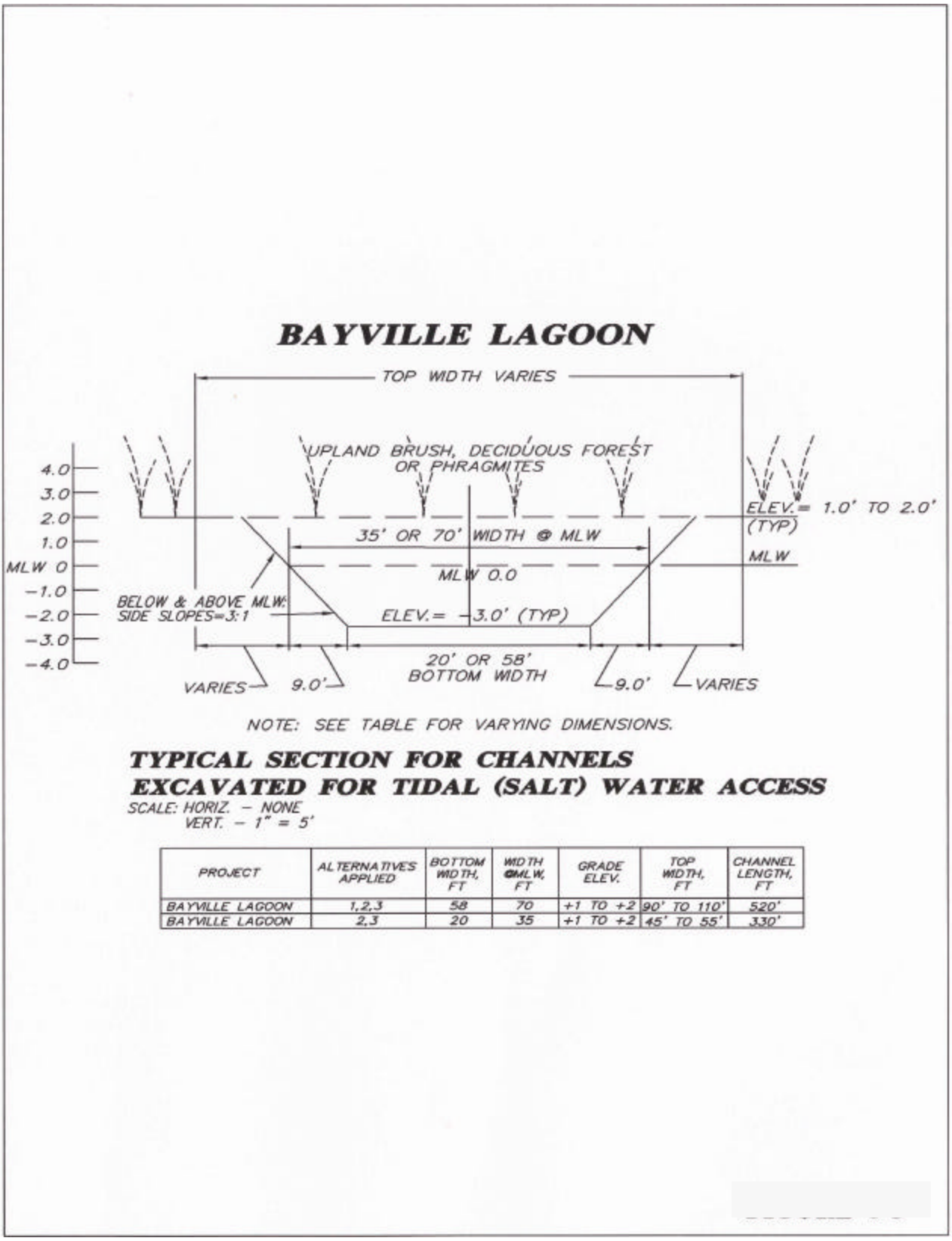


Figure 6-4 BAYVILLE LAGOON-TYPICAL SECTION OF TRIPLE 64"x43" COATED CMPA CULVERT PIPES UNDER EXISTING ROADS



PROJECT	ALTERNATIVES APPLIED	BOTTOM WIDTH, FT	WIDTH @MLW, FT	GRADE ELEV.	TOP WIDTH, FT	CHANNEL LENGTH, FT
BAYVILLE LAGOON	1,2,3	58	70	+1 TO +2	90' TO 110'	520'
BAYVILLE LAGOON	2,3	20	35	+1 TO +2	45' TO 55'	330'

Figure 6-5 BAYVILLE LAGOON TYPICAL SECTION FOR CHANNELS EXCAVATED FOR TIDAL (SALT) WATER ACCESS

6.2.3 Oyster Creek

The selected plan, shown in Figure 6-6, consists of the excavation of a meandering and braided open channel system of approximately 35 feet in width at MLW and 9,400 feet in length, connected to the Bay at the east and in the south through 100-foot wide openings provided through the existing timber bulkhead. This channel system will introduce tidal water to the areas occupied by phragmites through direct contact up to the elevation of approximately +2.0 MLW during each daily tidal cycle, as well as through the establishment of a capillary fringe above and along either side of the channel. The introduction of the tidal water to this area will result in the degradation of the phragmites and its eventual replacement by higher value wetland habitat. The channel excavation quantity is 65,500 cubic yards.

The typical cross section of the channel system is shown in Figure 6-7. The specified bottom width of the channel is 68 feet for one alternative and 20 feet for the others, with the bottom elevation to be set at –3.0 MLW, with a flat longitudinal slope, and the side slopes to be 3:1 (horizontal on vertical) below MLW, and on 5:1 above MLW.

The approximate depth of the capillary fringe with minimum 25% saturation is estimated to be 5 feet beyond the elevation +2.0 MLW on either side the channel. This estimate is based on the capillary criteria (Figure 6-8) for silty sand soils covering the phragmites area.

A site-specific soil sampling and analysis was not performed. However, based on all evidence, the soils at the site are sandy silt material, which is closest to the material referred to as "Bennet sandy loam" represented by the curve on the left-hand side in Figure 6-8. According to this figure, 25% saturation corresponds to approximately 5 feet, which has been used as the typical value for the "capillary fringe" in this "feasibility" study. The actual effective length of the capillary fringe can only be determined through laboratory tests with the actual material samples, and ultimately in the field after the construction is completed.

Access for all construction equipment and materials can be by land or by water. Land access is available using a public road running along the north boundary of the site. For access by water, the offloading area for equipment and materials will be located along the shoreline section at the entrance to Oyster Creek. For the feasibility study, land access is selected for cost estimating purposes.

The area occupied by the existing phragmites would be cleared by spraying the project area with a herbicide followed by controlled burning. Designated upland areas at the west end and higher elevations would be used for disposal of the burned phragmites.

A long reach excavator(s) would typically be used as the primary equipment for excavation and placement of material in off highway haulers for transport to the designated on-site disposal locations appropriate for the specific alternative. A light grader would be used to spread the excavated material in the disposal area.

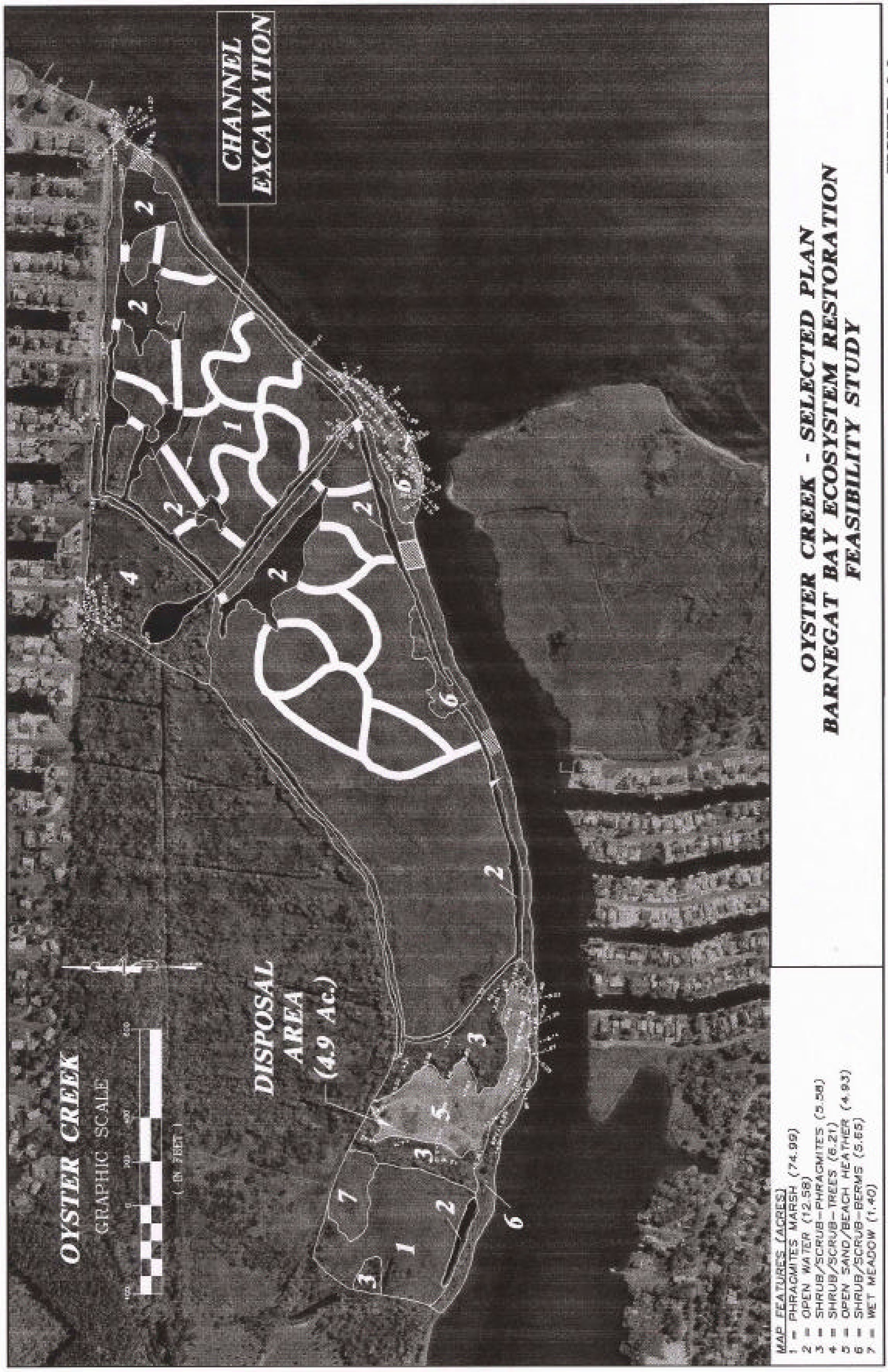
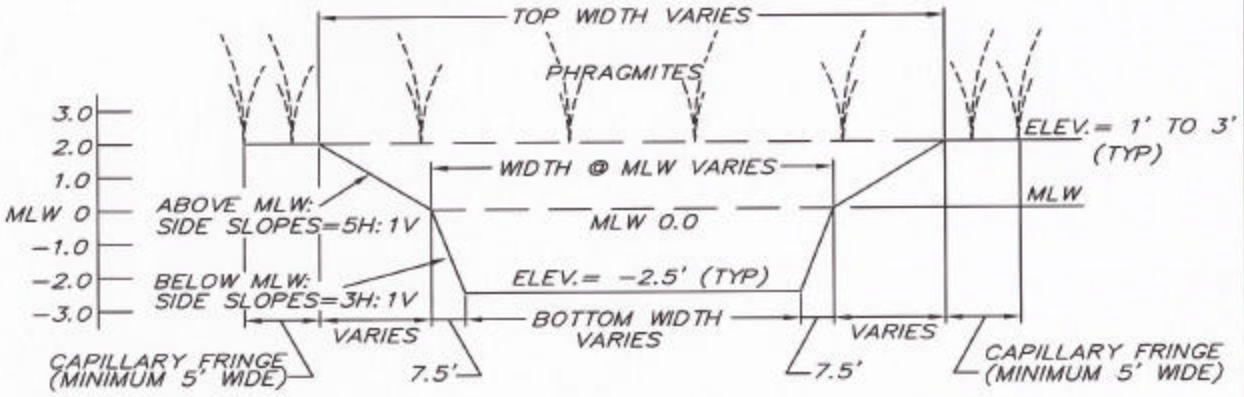


Figure 6-6 OYSTER CREEK- SELECTED PLAN



NOTE: SEE TABLE FOR VARYING DIMENSIONS.

TYPICAL SECTION FOR CHANNELS EXCAVATED FOR TIDAL (SALT) WATER ACCESS

SCALE: HORIZ. – NONE
VERT. – 1" = 5'

PROJECT	ALTERNATIVES APPLIED	BOTTOM WIDTH, FT	WIDTH @MLW, FT	GRADE ELEV.	TOP WIDTH, FT	CHANNEL LENGTH, FT
FLAT ISLAND	2	20	35	+2 TO +3	55 TO 65	13,000
FLAT ISLAND	3	20	35	+2 TO +3	55 TO 65	10,000
FLAT ISLAND	4	20	35	+2 TO +3	55 TO 65	5,000
OYSTER CREEK	2	68	83	+2 TO +3	103 TO 113	1,900
OYSTER CREEK	3	20	35	+2 TO +3	55 TO 65	9,400
OYSTER CREEK	4	20	35	+2 TO +3	55 TO 65	15,900
BAYVILLE LAGOON	2,3,4	58	73	+1 TO +2	83 TO 93	500
BAYVILLE LAGOON	3	20	35	+2 TO +3	APPROX. 60'	300
BAYVILLE LAGOON	4	20	35	+1 TO +3	APPROX. 50'	300

Figure 6-7 OYSTER CREEK TYPICAL SECTION FOR CHANNELS EXCAVATED FOR TIDAL (SALT) WATER ACCESS

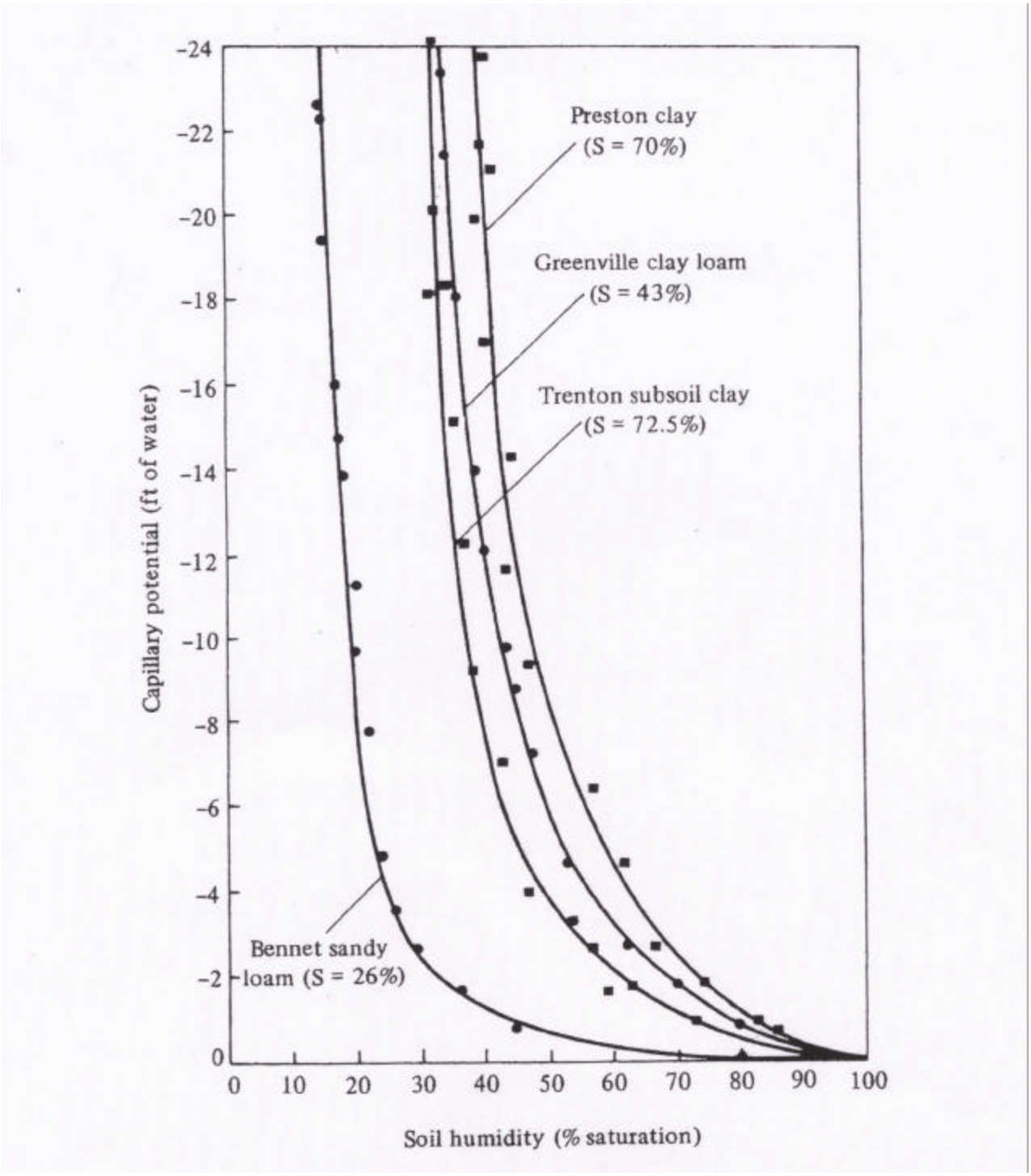


Figure 6-8 Desorption curves for four soil types (data same as for Fig. 10-9)

The material excavated to create the channel system would be placed in the designated upland areas. The excavated material would be placed in 6-inch lifts using temporary geomats and a light grader to spread the excavated material in the disposal area. Sand will not be compressed if 6-inch lifts are placed and temporary geomats and graders are used properly, as per the specifications that would be part of the final construction documents.

6.2.4 Barnegat Lighthouse

The selected plan, shown in Figure 6-9, consists of the excavation of a pond with a surface area of approximately 5 acres measured at MHW with access to tidal water landward of the Barnegat Inlet south jetty by means of two inlets formed by two open channels. The open channel inlets would have a bottom width of 10 feet and side slopes of 4:1, resulting in top widths of 50 to 66 feet depending on the existing ground elevations at the top of the bank. (See Figure 6-10.) The pond/channel excavation quantity is 67,200 cubic yards. The entire length of the entrance channel would be lined with erosion control matting. Additionally, two golf-cart size, low rail height bridges would be constructed across the open channel inlets.

Access by land will be utilized in this project via several plausible access points from the streets in the residential area on to the project site. The best access would be determined during construction document preparation with appropriate and timely coordination with the local authority and residents.

For the construction of the ponds and open channels, as well as for grading, it is stipulated that small backhoe type machinery would typically be used as the primary equipment for excavation and hauling of material, and for grading.

It is stipulated that all excavated material, including the top soil that contains beach grass, would be deposited in designated, appropriate areas on site.

6.2.5 Stafford Forge

The selected plan, shown in Figure 6-11, consists of adding a fish ladder and eel passage to the existing water control structure at Pond 5; creating fish passage by refurbishing existing riser pipe culvert systems in the stream channel of Westecunk Creek across the berm extending to Pond 2 and through the berm defining the downstream perimeter of Pond 1; and refurbishing existing water control structures and installing three water control structures at Ponds 2, 3 and 4 to lower the water levels to an average of 18 inches.

Access for all construction equipment and materials will be accomplished via the existing public roads leading to the site and the network of roads within the site.

Small backhoe type machinery would typically be used as the primary equipment for the structural modifications, installation of new structures, as well as for any excavation and hauling of material and for grading as appropriate for the specific alternative. The existing berms and

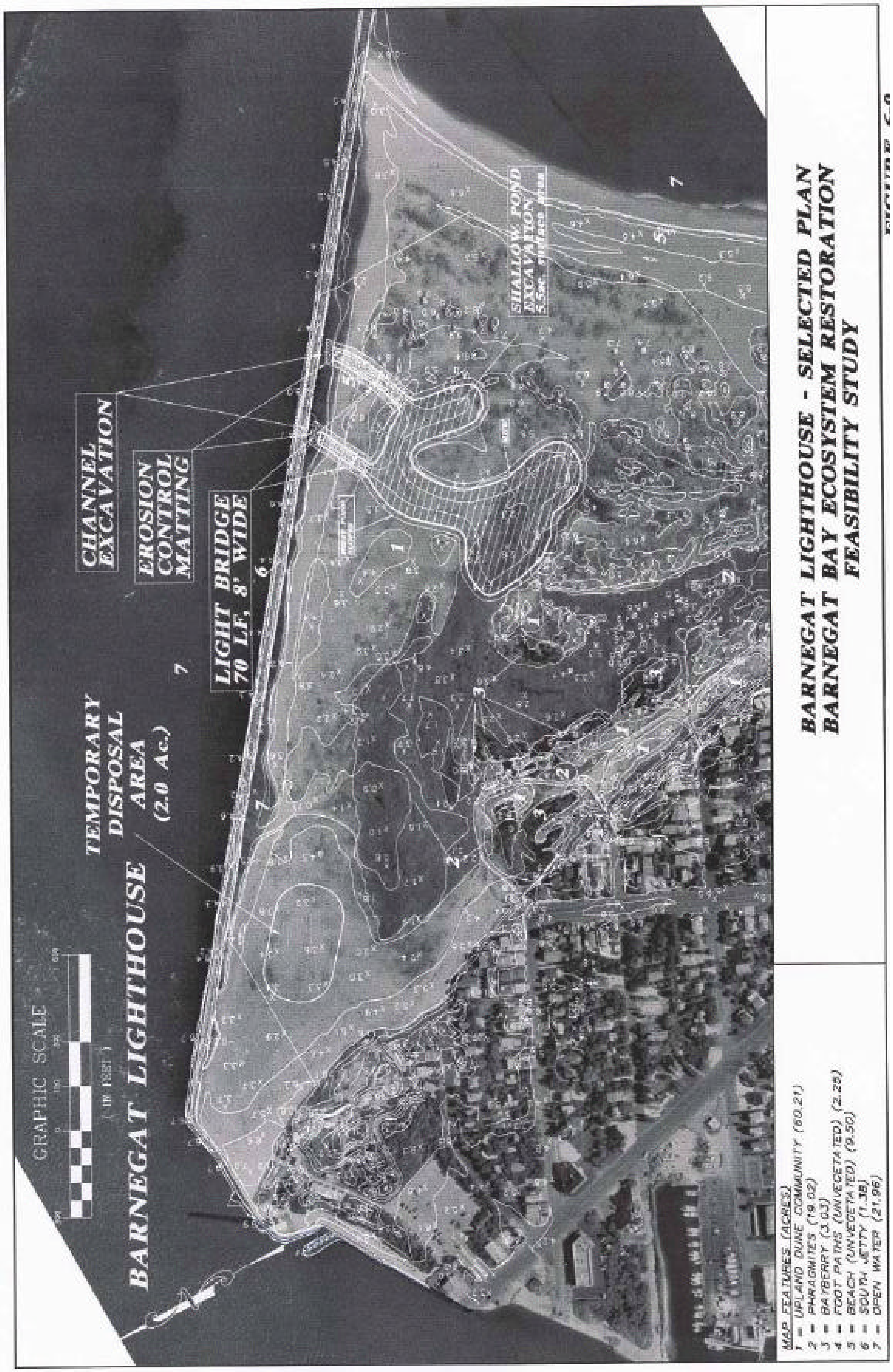
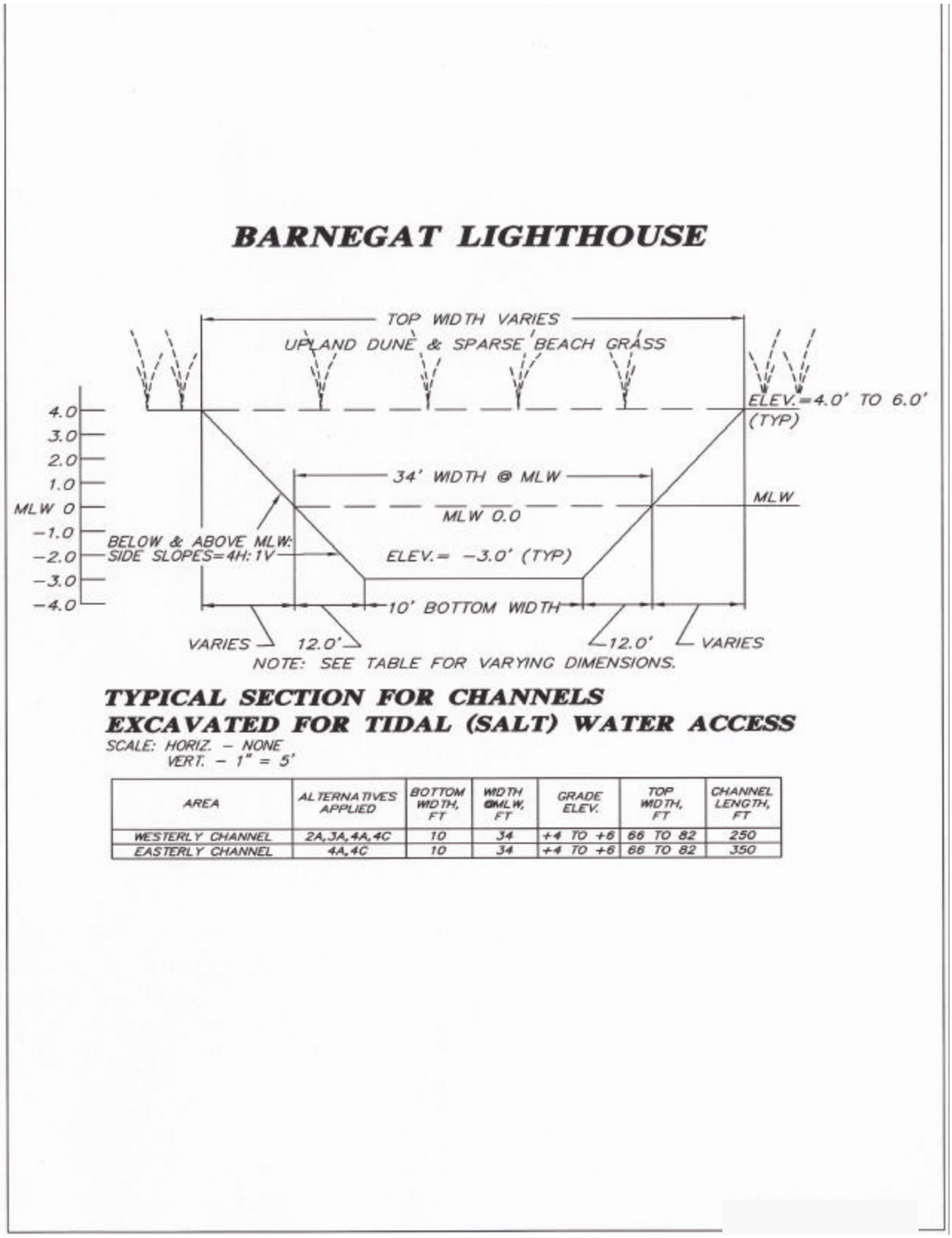


Figure 6-9 BARNEGAT LIGHTHOUSE-SELECTED PLAN



AREA	ALTERNATIVES APPLIED	BOTTOM WIDTH, FT	WIDTH @MLW, FT	GRADE ELEV.	TOP WIDTH, FT	CHANNEL LENGTH, FT
WESTERLY CHANNEL	2A, 3A, 4A, 4C	10	34	+4 TO +6	66 TO 82	250
EASTERLY CHANNEL	4A, 4C	10	34	+4 TO +6	66 TO 82	350

Figure 6-10 BARNEGAT LIGHTHOUSE TYPICAL SECTION FOR CHANNELS EXCAVATED FOR TIDAL (SALT) WATER ACCESS

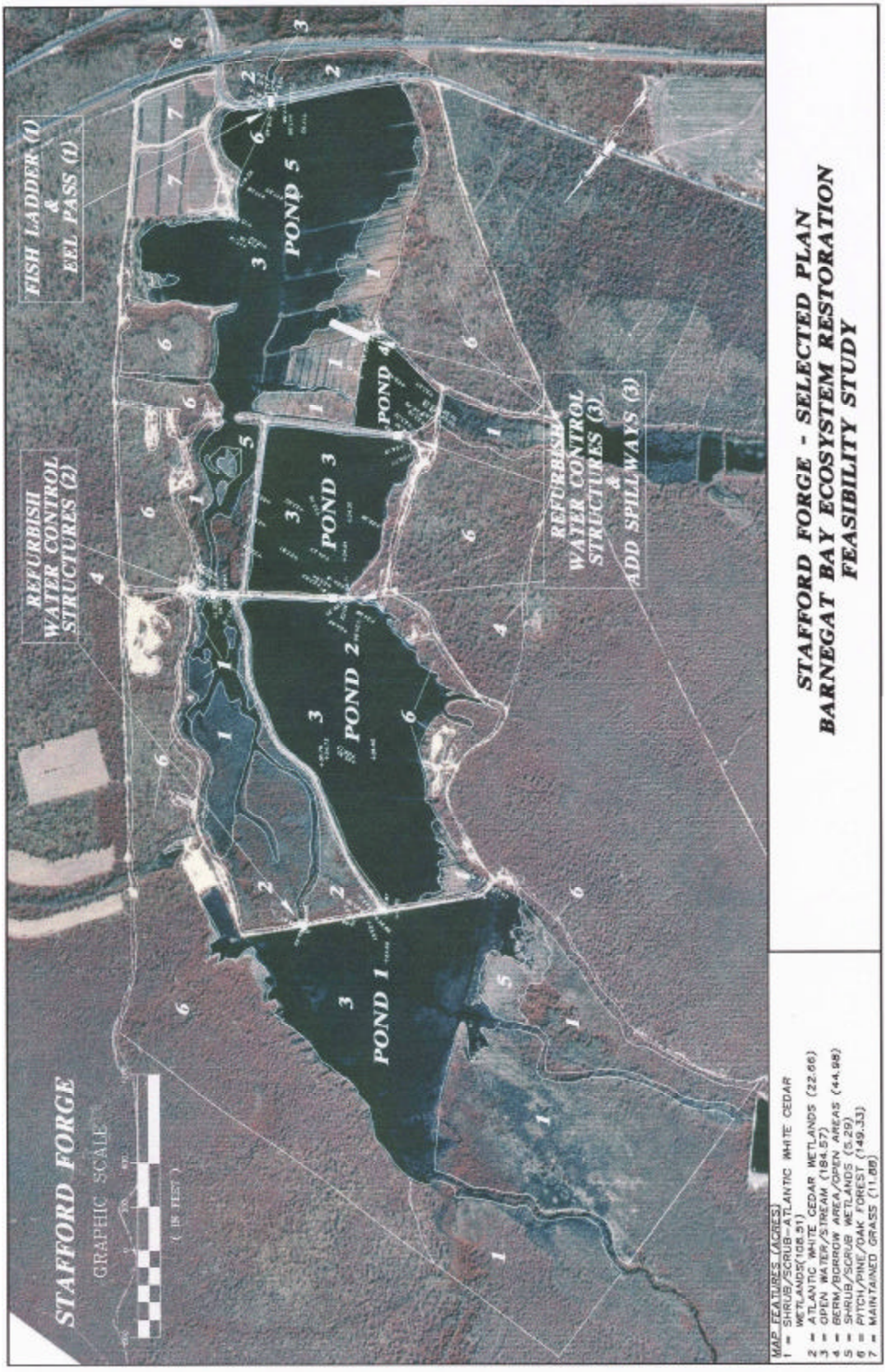


Figure 6-11 STAFFORD FORGE- SELECTED PLAN

other dirt roads would be used to the maximum extent practical for hauling activities, utilizing temporary geo-mats or equivalent material where necessary for base support.

The material excavated from the berms to create the spillways for Ponds 2, 3 and 4 would be hauled to the borrow area north of the stream in the vicinity of the beaver dam. Any material from the demolition of structural components would be hauled offsite.

6.2.6 Flat Island

The selected plan, shown in Figure 6-12, consists of excavating a meandering and braided open channel system throughout a total area of approximately 10.7 acres in the western portions of the island. This channel system will introduce tidal water to the areas occupied by phragmites through direct contact up to the elevation of approximately +2.0 MLW during each daily tidal cycle, as well as through the establishment of a capillary fringe above and along either side of the channel. The introduction of the tidal water to this area will result in the degradation of the phragmites and its eventual replacement by higher value wetland habitat. The channel system will be approximately 10,000 feet in length with the average cross-section including 70 square feet below MLW and 130 square feet above MLW. The channel excavation quantity is 55,700 cubic yards. Based on the area in direct contact with tidal exchange and the capillary fringe, this plan would result in tidal marsh re-creation of approximately 10.08 acres.

The typical cross section of the channel system is shown in Figure 6-13. The specified bottom width of the channel is 20 ft, with the bottom elevation to be set at –3.0 MLW, with a flat longitudinal slope, and the side slopes to be 3:1 (horizontal on vertical) below MLW, and on 5:1 above MLW. The field observations and limited supplementary surveys by AMA indicate that existing ground elevations are generally in the range of +2 to +3 MLW throughout the areas where this excavation would take place.

The approximate depth of the capillary fringe with minimum 25% saturation is estimated to be 5 feet beyond the elevation +2.0 MLW on either side the channel. This estimate is based on the capillary criteria (Figure 6-8) for silty sand soils covering the phragmites area.

A site-specific soil sampling and analysis was not performed. However, based on all evidence, the soils at the site are sandy silt material, which is closest to the material referred to as "Bennett sandy loam" represented by the curve on the left-hand side in Figure 4.4. According to this figure, 25% saturation corresponds to approximately 5 feet, which has been used as the typical value for the capillary fringe in this feasibility study. The actual effective length of the capillary fringe can only be determined through laboratory tests with the actual material samples, and ultimately in the field after the construction is completed.

Access for all construction equipment and materials will be required by water. The offloading area for equipment and materials will be located along the northwest shoreline of the island.
The area occupied by the existing phragmites would be cleared by spraying the project area with an herbicide, followed by controlled burning. Designated upland scrub areas at higher elevations (identified by Versar – February 2001) would be used for disposal of the burned phragmites.

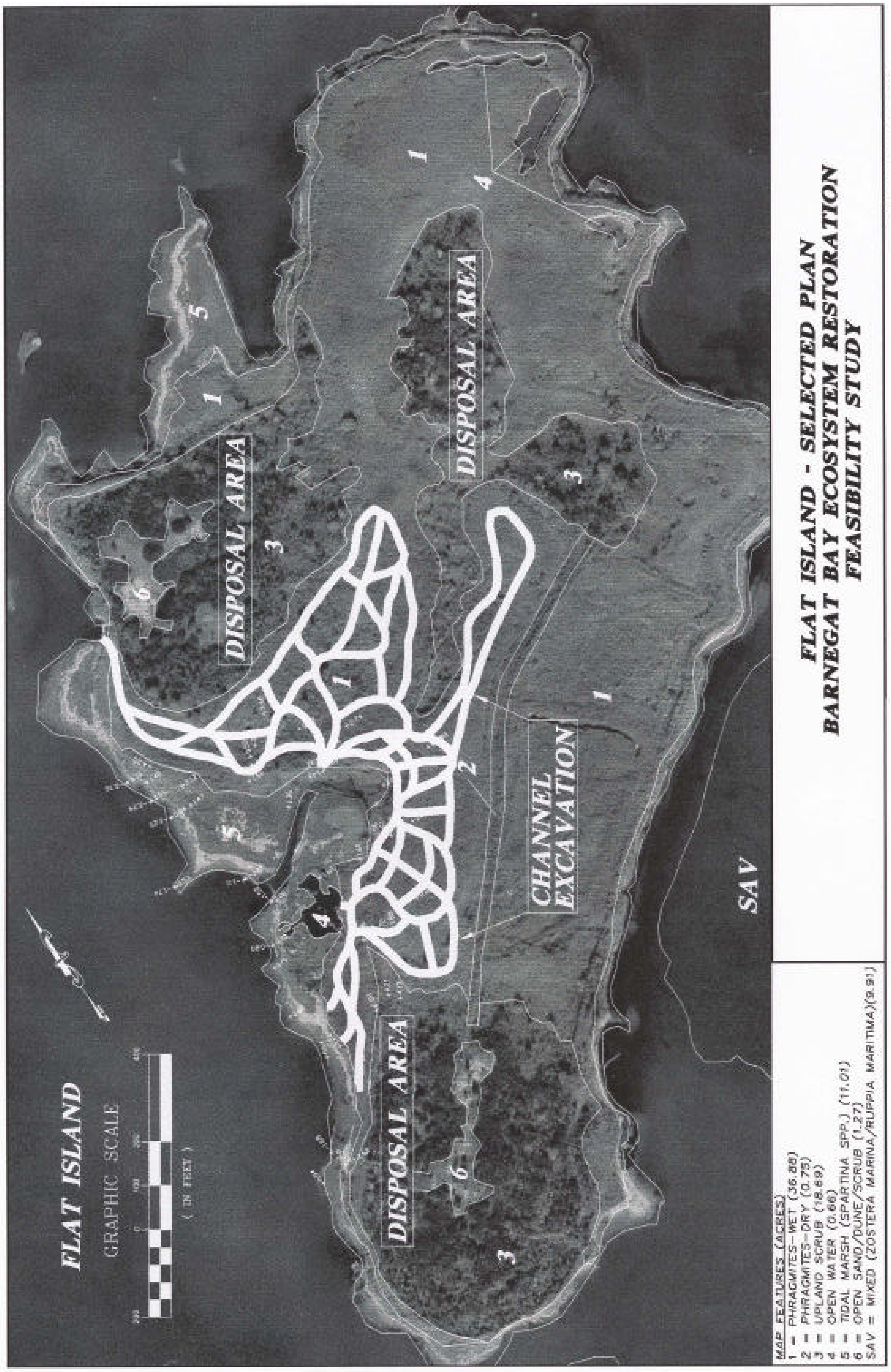
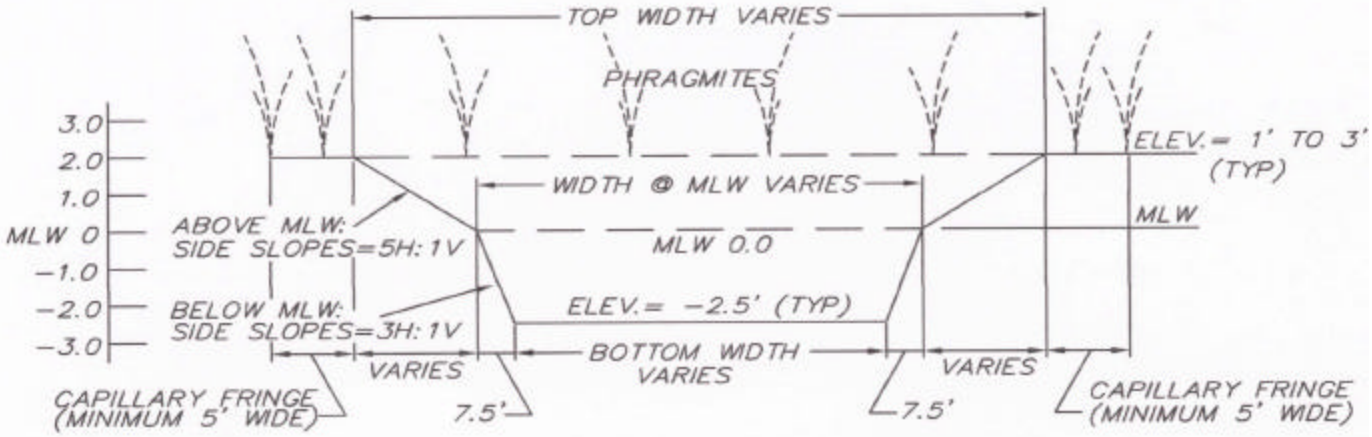


Figure 6-12 FLAT ISLAND- SELECTED PLAN

FLAT ISLAND



NOTE: SEE TABLE FOR VARYING DIMENSIONS.

TYPICAL SECTION FOR CHANNELS EXCAVATED FOR TIDAL (SALT) WATER ACCESS

SCALE: HORIZ. – NONE
VERT. – 1" = 5'

PROJECT	ALTERNATIVES APPLIED	BOTTOM WIDTH, FT	WIDTH @MLW, FT	GRADE ELEV.	TOP WIDTH, FT	CHANNEL LENGTH, FT
FLAT ISLAND	2	20	35	+2 TO +3	55 TO 65	13,000
FLAT ISLAND	3	20	35	+2 TO +3	55 TO 65	10,000
FLAT ISLAND	4	20	35	+2 TO +3	55 TO 65	5,000
OYSTER CREEK	2	68	83	+2 TO +3	103 TO 113	1,900
OYSTER CREEK	3	20	35	+2 TO +3	55 TO 65	9,400
OYSTER CREEK	4	20	35	+2 TO +3	55 TO 65	15,900
BAYVILLE LAGOON	2,3,4	58	73	+1 TO +2	83 TO 93	500
BAYVILLE LAGOON	3	20	35	+2 TO +3	APPROX. 60'	300
BAYVILLE LAGOON	4	20	35	+1 TO +3	APPROX. 50'	300

Figure 6-13 FLAT ISLAND TYPICAL SECTION FOR CHANNELS EXCAVATED FOR TIDAL (SALT) WATER ACCESS

A long reach excavator(s) would typically be used as the primary equipment for excavation and placement of material in off highway haulers for transport to the designated on-site disposal locations appropriate for the specific alternative. A light grader would be used to spread the excavated material in the disposal area.

The material excavated to create the channel system would be placed in the designated upland areas. The excavated material would be placed in 6-inch lifts using temporary geomats and a light grader to spread the excavated material in the disposal area. Sand will not be compressed if 6-inch lifts are placed and temporary geomats and graders are used properly, as per the specifications that would be part of the final construction documents.

6.3 COMPARISON OF WITH & WITHOUT PROJECT CONDITIONS

In order to determine the benefits of the alternative plans, the "without-project" conditions must be identified and evaluated in terms of future environmental and economic conditions. The "with-project" plans should then be formulated and compared to the "without-project" conditions to evaluate the benefits and impacts of the selected plans. The "with-project" evaluation should address structural and hydraulic conditions, as well as environmental consequences. Evaluations shall consider construction and operations impacts relevant to human health, natural and cultural resources, and socio-economic factors of the project sites and surrounding communities.

6.3.1 Without Project Conditions

6.3.1.1 F&L Abandoned Lagoons

Under present conditions, the F&L Abandoned Lagoon site has experienced a significant loss of habitat from dredging and filling operations. The approximately 16.7-acre site was almost certainly excavated directly from the native tidal marsh, resulting in a direct loss of ecologically valuable wetlands. The construction of lagoon communities in this part of Barnegat Bay has undoubtedly been responsible for the greatest wetlands losses in the vicinity.

The excavated and abandoned lagoons in the area have added to the deterioration of local water quality in the Bay. This degraded water quality is primarily a result of the generally deep, poorly-flushed environments of the lagoons where dissolved oxygen is low. F Lagoon, in particular, attracts and concentrates many power boats in one small area, which potentially further degrades water quality, and L Lagoon possesses especially poor water quality.

The expected future without project condition is a continuation of the present conditions, i.e., lost habitat and degraded water quality that adversely impact the native juvenile fish, benthos, invertebrates, and diamondback terrapin communities in the project area.

6.3.1.2 Bayville Abandoned Lagoon

Under present conditions, the Bayville Abandoned Lagoon site has experienced a significant loss of habitat from dredging and filling operations. The open water parts of the site, totaling 5.96 acres were almost certainly excavated directly from the native tidal marsh, resulting in a

direct loss of ecologically valuable wetlands. Almost 14 acres of tidal marsh were also filled with materials excavated during the lagoon creation. The construction of lagoon communities in this part of Barnegat Bay has undoubtedly been responsible for the greatest wetlands losses in the vicinity.

The excavated lagoon at the site has added to the deterioration of local water quality in the Bay primarily because it is a generally deep, poorly-flushed environment where dissolved oxygen is low. Bayville Abandoned Lagoon possesses especially poor water quality.

The expected future without project condition is a continuation of the present conditions, i.e., lost habitat and degraded water quality that adversely impact the native juvenile fish, benthos, invertebrates and black ducks in the project area.

6.3.1.3 Oyster Creek

Under present conditions, the Oyster Creek site has experienced a significant loss of habitat from filling operations that placed dredged materials over the entire 111 acres of the site, including fill presumably placed directly over the original tidal marsh along Oyster Creek. The area with the greatest quantity of fill is in the western section of the site with dredged fill placed 8 to 10 feet above mean high water. Other areas of the site possess between 1 foot and 6 feet of fill. The majority of the site possesses between 1 and 3 feet of fill.

The site is presently dominated in most areas by dense, thick, monotypic stands of phragmites marsh. The thin layer of fill in most areas prevents regular tidal exposure or inundation of the phragmites by the saline conditions of Oyster Creek. As the site is completely cut off from regular tidal fluctuation, it is presumed that the existing phragmites would remain entrenched on the site without intervention.

The expected future without project condition is a continuation of the present conditions, i.e., lost habitat and phragmites domination which adversely impact the native juvenile fish, benthos, invertebrates, marsh birds, other wildlife and diamondback terrapin in the project area.

6.3.1.4 Barnegat Lighthouse

Under present conditions, the Barnegat Lighthouse site has experienced a significant loss of habitat from filling operations that placed dredged materials on the site during construction of the south jetty. A large, apparently natural pond was filled in. Some areas of dune were lost as a result of the placement of the materials. Construction of the jetty has apparently resulted, however, in strong accretion of new dunes and building of the existing dunes. The activities at the site have resulted in dune building at the site. These areas have been allowed to vegetate, however, resulting in inadequate habitat for piping plovers.

A large part of the site (about 19 acres total) is currently dominated by phragmites. The phragmites apparently got started in the wettest area of the former pond (after it was filled) and spread to the south from there. It is uncertain at this time whether the phragmites will spread further through other areas of the site. It is unlikely that it will colonize the high dunes because of the existing vegetation and the dryness in these areas.

The expected future without project condition is a continuation of the present conditions, i.e., lost habitat and phragmites domination which adversely impact the existing breeding population of piping plovers, marsh birds and other wildlife in the project area.

6.3.1.5 Stafford Forge

Under present conditions, the Stafford Forge site has experienced a significant loss of habitat due to hydrological modifications. This habitat loss is a result of the construction of berms and placement of water control structures for cranberry production at the site which flooded valuable stream, wetland, and upland habitats and replaced them with relatively sterile open water habitats. A significant amount of Atlantic white cedar wetlands were apparently lost by flooding of the ponds and stream habitats. The water control structures also serve as barriers to anadromous (herring), catadromous (eel), and resident fish populations on Westecunk Creek. The open water habitats provide a very poor fishery and are surprisingly little-used by ducks, waterfowl, and other wildlife.

The site presently suffers from degraded water quality resulting from the ponded, converted stream habitats that have contributed to the deterioration of local water quality in Westecunk Creek, and ultimately in the Bay. This degradation is primarily due to the broad, poorly-flushed environments where dissolved oxygen is lowered, and temperatures and nutrient levels are raised. In addition, the physical habitats of Westecunk Creek have been altered immediately above and below the site, further exacerbating water quality problems. The natural Atlantic white cedar wetlands that protected water quality and buffered the creek were largely removed and replaced with the large open water ponds as part of the former cranberry bog operation.

The expected future without project condition is a continuation of the present conditions, i.e., lost habitat and degraded water quality which adversely impact the existing anadromous and catadromous fishes (river herring and American eel, respectively), black ducks and other wildlife in the project area.

6.3.1.6 Flat Island

Under present conditions, the Flat Island site has experienced a significant loss of habitat from filling operations that placed dredged materials at the site. Although it is not currently certain whether dredged materials were originally placed directly on tidal marsh, uplands, or open water (or a combination of these) to create the disposal island, it is most likely that the fill was placed directly on tidal marsh. Assuming the deposition was originally on tidal marsh, this would equate to a historic loss of about 58 acres of tidal marsh.

Presently, more than half of Flat Island is dominated by a dense stand of phragmites marsh that is firmly established. Because of its density and tenacity, it is not likely that this condition will change without intervention. The high wildlife value of the large area of tidal marsh and the at least moderate value of the upland scrub areas are sharply contrasted with the phragmites dominated area that is apparently of very little value to wildlife.

The expected future without project condition is a continuation of the present conditions, i.e., lost habitat and phragmites domination that adversely impact a suite of marsh birds (marsh wren, sharp-tailed sparrow, seaside sparrow, etc.) and other wildlife in the project area.

6.3.2 With Project Conditions

6.3.2.1 F&L Abandoned Lagoons

Alternative 3, the selected plan, would maximize new habitats for juvenile fish, benthos, invertebrates, and diamondback terrapin by providing a total of 8.45 acres of fish and benthos habitat and 3.27 acres of diamondback terrapin habitat. The project goals would be realized through a combination of decreasing existing lagoon depths to an average of 6 feet, improving water quality (by improving circulation and decreasing depth), and flattening/clearing existing sandy piles (for terrapin habitat). The 6-foot average depth would likely provide for SAV growth with its attendant benefits for fish and wildlife habitat, and water quality. Two separate parcels of ideal terrapin habitat would be created; both would be completely isolated from predators by substantial waterways. The alternative would supply the best circulation (linking directly to water quality) of all the alternatives without deepening the entrance channel to the L Lagoon.

6.3.2.2 Bayville Abandoned Lagoon

Alternative 4, the selected plan, would maximize new habitats for juvenile fish, benthos, invertebrates, and black duck by providing a total of 4.79 acres of fish and benthos habitat. The project goals would be realized through a combination of decreasing existing lagoon depths to an average of 6 feet and improving water quality (by improving circulation and decreasing depth). The 6-foot average depth would likely provide for SAV growth with its attendant benefits for fish and wildlife habitat, and water quality. The new SAV habitat would be additive to the existing SAV habitat in the shallow area of the lagoon, valuable to black ducks and other dabbling waterfowl. Alternative 4 would also have the secondary benefit of directly converting some of the existing phragmites marsh, which are large and of relatively poor habitat quality, to new tidal marsh habitat and open water.

6.3.2.3 Oyster Creek

Alternative 3, the selected plan, would maximize new habitats for a suite of marsh birds (marsh wren, sharp-tailed sparrow, seaside sparrow, etc.) and other wildlife, and diamondback terrapin providing a total of 18.31 acres of new tidal marsh habitats for marsh birds and 10.14 acres of new open sandy habitats for diamondback terrapins. The project goals would be realized by opening the site to tidal, saline Bay water through a system of open channels. All of the channels would be cut primarily through dense, nontidal phragmites marsh, and would incorporate the existing system of small, shallow ponds and ditches. Clean, sandy materials excavated from the channels would be deposited on the existing semi-open sandy area and adjacent upland phragmites habitats.

6.3.2.4 Barnegat Lighthouse

Alternative 4A, the selected plan, would maximize new habitats for an existing breeding population of piping plover and would also likely benefit other state listed birds such as least tern and other uncommon/rare bird species. Alternative 4A would provide approximately 6.72 acres of new shallow intertidal pond habitat with two open entrance channels. The proposed location for the new intertidal pond presents an ideal physical situation for maximizing use by the resident breeding piping plovers and provides a large amount of surface area for feeding adjacent to the existing nesting sites. The two open channels created for Alternative 4A would also require 2 access bridge structures.

6.3.2.5 Stafford Forge

Alternative 7, the selected plan, would allow for passage of anadromous and catadromous fishes (river herring and American eel, respectively) on Westecunk Creek at and above the Stafford Forge site, and would also convert several large off-stream open water ponds to more ecologically valuable vegetated emergent wetlands with interspersed small areas of open water. Alternative 7 would create a total of over 184.43 acres of on-site habitat. In addition, a maximum of approximately 10.2 combined stream miles would be made available to fish on Westecunk Creek above Stafford Forge.

6.3.2.6 Flat Island

Alternative 3, the selected plan, would maximize new habitats for a suite of marsh birds (marsh wren, sharp-tailed sparrow, seaside sparrow, etc.) and other wildlife providing a total of 10.8 acres of tidal marsh habitat. The new habitat would be created by opening the site to tidal, saline Bay water through a system of open channels that would connect to existing tidal marsh. All of the channels would be cut primarily through dense, nontidal phragmites marsh.

6.4 ENVIRONMENTAL EFFECTS

This section evaluates the expected environmental and socioeconomic consequences of the proposed action (implementation of the selected alternative plan at each site). No potential environmental impacts are associated with Alternative 1 of any of the six sites, as this is the No-Action plan for each site.

6.4.1 F&L Abandoned Lagoons

6.4.1.1 Physical Setting

The proposed action (implementation of the selected alternative plan) could affect the existing topography in several areas of the site, depending on the source of material for use in the bottom-raising of the F & L Abandoned Lagoons. If the existing steep, sandy berms were used as a source of material, the existing scrubby upland vegetation would be cleared and the sand material would be taken directly from the piles. Previous measurements of the berms at the F&L Abandoned Lagoons indicated that more than enough material exists for the proposed bottom-

raising (Harriott and Southerland 2001). Given this, it is likely that some sandy materials would remain on the berms after project implementation (i.e., mounded berms would remain, but would not be as steeply-sided). One exception to this would be the two new terrapin habitat areas where most of the material will be excavated (leaving enough to keep the areas above the average high tide); the rest of the material will be graded essentially flat to maximize terrapin access to the sites.

It was estimated that a total of 63,000 cubic yards of material would be required (in addition to the 6,700 cubic yards of material resulting from the channel excavation) for the bottom-raising of both lagoons proposed under Alternative 3 (AMA 2002). The existing upland berms occupy a total of 9.58 acres combined at the F&L Abandoned Lagoons. Based on the large quantity of material existing on these berms (a total of approximately 176,737 cubic yards of sandy materials; Harriott and Southerland 2001) it is likely that only portions of the berms would need to be excavated/flattened for bottom-raising materials. It is not likely that these changes in physical setting would have any significant adverse environmental, aesthetic, or other effects (refer to subsequent sections on Vegetation and Land Cover and Aesthetics).

As noted in previous reports (Harriott and Southerland 2001) the existing berms at this site are artificial, man-made features on a landscape that historically consisted solely of tidal marsh. The lagoons and berms presumably replaced valuable vegetated tidal marsh habitats for native marsh nesting birds and other declining species. Therefore, any reduction in the size of the berms could be viewed as positive environmental impacts on the physical setting. Further, these upland features currently appear to contribute little to overall ecological functioning. Therefore, impacts on physiography and topography would likely be minimal.

There would be no effects on the physiography and topography of the F&L Abandoned Lagoons if an alternate source of bottom-raising materials were used (e.g., dredged clean sandy materials piped in or barged in from a nearby off-site source).

6.4.1.2 Land Use

The proposed action would not alter the existing land uses of the F&L Abandoned Lagoons site. The site is owned by the USFWS and is maintained in a semi-natural state; this would remain unchanged after implementation of the project.

6.4.1.3 Fish and Wildlife

The proposed action is anticipated to have only minor, temporary impacts on aquatic wildlife within the two lagoons, resulting from potential turbidity during filling operations. No long-term negative impacts are anticipated as a result of the proposed action. On the contrary, restoring habitats closer to average conditions in undisturbed areas of Barnegat Bay would likely increase populations of fish and benthos at both lagoons. Greater numbers of fish and benthos at this site could also provide additional foraging opportunities for piscivorous birds, fish, and other wildlife.

Deposition of clean, sandy material in the lagoons will cause a temporary increase in turbidity and suspended materials. These materials could decrease visibility, impacting the ability of some fish to visually acquire prey or avoid threats. They are, however, unlikely to cause physical impacts since fish are highly mobile and will avoid such disturbances by temporarily relocating to an undisturbed habitat. Given the poor water quality and bottom substrate existing at the lagoons, it is unlikely that either fish eggs, larvae, or a significant number benthos utilize this habitat; short-term impacts are therefore expected to be relatively minor. These impacts are expected to be rapidly offset as fish and benthos move into newly restored habitat. Because better quality habitat will be available after placement, the restored habitat is expected to support a greater diversity and density of fish and benthos. The proposed action could improve habitat for important commercial and recreational fishery resources such as winter flounder, blue crabs, blue fish, Atlantic menhaden, and striped bass.

The proposed action is also anticipated to pose only minor, temporary impacts on terrestrial wildlife. Several areas of the existing berms would have to be cleared of their existing scrubby upland vegetation, in preparation for material removal (for lagoon fill) and/or flattening (for terrapin habitat). The existing vegetation on the berms consists of a mixture of very small trees and shrubs. It was noted in a number of visits to the site that a few common species of birds (e.g., American goldfinch, eastern kingbird, red-winged blackbird) likely nest in these habitats, but they are apparently not abundant (Harriott and Southerland 2001). Because of their lack of physical vegetative structure (the herbaceous layer is absent in most places on the berms) and lack of species diversity (they are steep-sided, excessively drained, and have been colonized by several pioneer species) the upland vegetation does not currently provide valuable wildlife habitats.

No adverse effects to the adjacent mapped EFH are anticipated. On the contrary, the proposed action would create 8.45 acres of ideal new fish and benthic habitats that are very likely to improve conditions for EFH species of concern.

6.4.1.4 Vegetation and Land Cover

Portions of the existing 13.54 acres of upland deciduous forest berm habitat would be affected by the proposed action. As proposed under Alternative 3, approximately 3.24 acres of the upland forest vegetation will be removed for berm flattening to create the two diamondback terrapin habitats. It has not yet been determined what, if any, specific areas of the berms would be used as borrow material for bottom-raising of the lagoons. The existing scrubby upland vegetation will be cleared from all sections of the berms to be used, and the sandy material will be removed where appropriate.

As previously noted (Harriott and Southerland 2001) the berms and their upland vegetation have only been in place for about 30 years, and are essentially a man-made, non-native habitat type on what was historically natural tidal marsh. There is no current evidence that the berms represent valuable habitats to nesting birds or other native wildlife. Finally, not all of the berms will need to be cleared; other areas of the upland berm habitats will remain unaffected. It is likely that woody vegetation will recolonize the excavated berms in places that remain well-drained.

Earth-moving equipment necessary for the clearing and material removal work on the berms could be brought in from the water by boat or barge, eliminating the need for improvements of the existing dirt paths that lead to the site and eliminating the potential related impacts to vegetation and land cover. Proper use of soil erosion and sediment control techniques and best management practices during all material removal and material flattening operations will also help to minimize both terrestrial and aquatic impacts.

6.4.1.5 Threatened and Endangered Species

The New Jersey Natural Heritage database indicated that records for one species, osprey (*Pandion haliatus*), exist for the vicinity of the F&L Abandoned Lagoons site. As previously indicated in this report, however, the description provided by Heritage for the 1992 record was from a location clearly off the F&L Abandoned Lagoons site. Ospreys were occasionally observed in the general area of the site during the environmental testing field studies (as they were in other areas of Barnegat Bay); no osprey nests were observed in the vicinity of the site. Based on the general nature of the proposed action and the small size of the site relative to potential adjacent habitats on the Bay, it is unlikely that ospreys would be either positively or negatively affected. Therefore, no adverse impacts are anticipated.

6.4.1.6 Wetlands

As mapped in the Barnegat Bay Ecosystem Restoration Environmental Testing and Restoration Proposals (Harriott and Southerland 2001), a total of approximately 15.9 acres of tidal and freshwater wetlands exist at the F&L Abandoned Lagoons site. The proposed action will not directly affect (i.e., through channel cutting, berm flattening, materials deposition in the lagoons, site access, or other activities) any of the existing vegetated wetlands at the F&L Abandoned Lagoons site. The small roughly triangular pond, now mapped as open water/pond/phragmites, and the narrow central phragmites area at the F Lagoon, now mapped as phragmites-wet, will likely be indirectly affected by overflow from the new east-west channel. The new east-west channel will carry regular tidal flow, and will likely overflow into the southern and northernmost parts of these existing wetlands, respectively. It is therefore likely that portions of these two existing wetlands will be converted from freshwater/brackish systems to more saline systems dominated by cordgrasses and other tidal wetlands species characteristic of the area. Considering that these two wetlands are dominated primarily by dense areas of phragmites, the partial conversion to tidal wetlands is viewed as a likely positive ecological change. Adverse effects, therefore, to existing vegetated wetlands will be minimal.

6.4.1.7 Air Quality

In the short-term, employee vehicles and construction equipment will cause a temporary increase in emissions of volatile organic compounds, nitrogen oxides, sulfur dioxide, and carbon monoxide. Emissions produced during construction are not expected, however, to exceed ambient air quality standards for the area. No long-term impacts to local air quality are expected from the proposed action; therefore no adverse effects are anticipated.

6.4.1.8 Hazardous and Toxic Materials

Existing data base information (as well as site observations during the ecological field studies) suggests little potential for encountering hazards on the F&L Abandoned Lagoons site. The data also indicate that there are no potential hazards on any directly adjacent properties. Several records of minor spills at a local marina farther than ¼ mile were mapped by Environmental Data Resources (EDR); other minor spill sites were also noted farther from the F&L Lagoons site. These mapped "contaminated" sites are not likely to have any negative effect on the proposed restoration. Therefore, no adverse effects relating to hazardous and toxic materials are anticipated as a result of the proposed action.

6.4.1.9 Water Resources

Site surface water quality will be improved as a result of the proposed action. Dissolved oxygen levels will be increased in both lagoons as a result of decreasing the average depth to 6 feet, and by increasing circulation. The existing circulation in the L Lagoon is poor; connecting it to the F Lagoon via the two new channels will likely greatly improve this condition. Daily tidal flushing will likely maintain higher dissolved oxygen levels in both lagoons in the warm months, despite the new shallower conditions. The improved water quality and increased shallowness in the lagoons will provide much better habitats for native fish and benthos. Therefore, no adverse effects relating to water resources are anticipated as a result of the proposed action.

6.4.1.10 Geology and Soils

Areas of the existing sandy berms would likely be excavated for use as clean fill material in the lagoons, and excavated and flattened for terrapin habitats. Materials excavated from the berms will be deposited in the lagoon to give it an overall depth of 6 feet. As previously indicated, not all areas of the berms would be excavated; these areas will remain intact. These berms are man-made and artificial; they are not representative of the native local topography (essentially very flat tidal marsh and open water). No adverse effects relating to native geology and soils, therefore, are anticipated as a result of the proposed action.

6.4.1.11 Recreational Resources

As proposed, the project will not likely affect access to the F Lagoon by recreational boaters; the 6-foot depth should allow easy access even at low tide. It is possible that the U.S. Fish and Wildlife Service, as owner's of the site, may choose to construct barriers to boat traffic at the entrance to the F Lagoon, before or after the project is implemented. This action would likely reduce recreational use by some boaters, while increasing the ecological benefit of the project (by reducing human disturbance of wildlife), but the action would be independent of the proposed project. The approximately 3.27 acres of created diamondback terrapin habitat should be securely fenced to protect these habitats from destruction by humans and their pets. Most of the boaters observed at the F Lagoon during the field studies apparently left their boats only rarely (likely owing to the density of the undergrowth and the steepness of the berms). It is therefore surmised that recreational aspects of the F Lagoon will remain virtually unchanged by the proposed action; no adverse effects, therefore, are anticipated. Access to the L Lagoon,

however, will remain restricted by the shallow, narrow entrance channel to the Metedeconk River, and by barriers on the two new channels between the lagoons.

6.4.1.12 Cultural Resources

A preliminary review of the information provided for this project area indicates a fairly low probability for the presence of archaeological sites. This project site is located in low lying area that has been subjected to flooding, erosion, and extensive previous construction activity. Consultation with the New Jersey State Historic Preservation Office is continuing and will be concluded prior to any construction activity.

F & L Abandoned Lagoons project area is located in low tidal marsh areas. In the project area, deep channel lagoons were excavated entirely from native tidal marsh deposits by developers in the 1960's and abandoned. Proposed connecting channel excavation in tidal marsh deposits will have no impact on cultural resources. Dredged material used for filling the lagoon may come from either adjacent backdirt piles created when the lagoons were initially dug, existing dredged material stockpiles located off site, or from maintenance dredging operations. These dredged material locations will be evaluated for cultural resources and the results closely coordinated with the NJ SHPO prior to construction.

6.4.1.13 Socioeconomic Resources

No socioeconomic impacts are anticipated.

6.4.1.14 Aesthetic/Visual Resources

Excavation of some areas of the berms at the F & L Abandoned Lagoons site may affect the viewshed at the site. Such effects are likely, however, to be positive. Excavation of any of the outer berms at both lagoons could result in new views of the expanse of marsh on all sides of the site. The overall aesthetic effect of the new viewsheds (particularly by opening the view to the north of the L Lagoon) would be improved by implementation of the proposed action. No adverse effects to aesthetic/visual resources are anticipated as a result of the proposed action.

6.4.1.15 Cumulative Impacts

Cumulative impacts may arise when the effects of individual actions that are not significant combine with the effects of other past, present, or reasonably foreseeable future actions (regardless of who undertakes these actions) to produce significant effects on resources. Whether adverse cumulative impacts are significant depends on the magnitude and extent of the effects and the capacity of the resources to withstand these effects.

Under the proposed action, restoration activities at F&L Abandoned Lagoons will benefit the biological resources and ecological condition of the Barnegat Bay ecosystem. When combined with other actions in the vicinity, these activities will augment environmental improvements or, at a minimum, slow degradation effects. No activities associated with the proposed action will contribute to adverse cumulative impacts.

6.4.2 Bayville Abandoned Lagoon

6.4.2.1 Physical Setting

The proposed action could affect the existing topography in several areas of the site, depending on the source of material for use in the bottom-raising of the Bayville Abandoned Lagoon. If the existing sandy berms were used as a source of material, the existing scrubby upland vegetation would be cleared and the sand material would be taken directly from the piles. The berms would likely have to be flattened somewhat from their existing (relatively steep) state for access by equipment. Previous estimates of the berms at the Bayville Abandoned Lagoon indicated that more than enough material likely exists for the proposed bottom-raising (Harriott and Southerland 2001). Given this, it is likely that some sandy materials would remain on the berms after project implementation (i.e., mounded berms would remain, but would not be as steeply-sided).

It is estimated that a total of 23,000 cubic yards of material would be required (in addition to the 5,700 cubic yards of material resulting from the channel excavation) for the bottom-raising of the lagoon proposed under Alternative 4 (AMA 2002). A total of approximately 16,667 cubic yards of sandy materials exists in the largest pile at the terminus of the existing dirt road (Harriott and Southerland 2001); portions of the berm to the immediate north of the lagoon would presumably be excavated for the remaining 6,333 cubic yards of the bottom-raising materials. It is not likely that these changes in physical setting would have any significant adverse environmental, aesthetic, or other effects (refer to subsequent sections on Vegetation and Land Cover and Aesthetics).

As noted in a previous report (Harriott and Southerland 2001) the existing berms at this site are artificial, man-made features on a landscape that historically consisted solely of tidal marsh. The lagoon and berms presumably replaced valuable vegetated tidal marsh habitats for native marsh nesting birds and other declining species. Therefore, any reduction in the size of the berms could be viewed as positive environmental impacts on the physical setting. Further, these upland features currently appear to contribute minimal overall ecological function. Therefore, impacts on physiography and topography would likely be minimal.

There would be no effects on the physiography and topography of the Bayville site if an alternate source of bottom-raising materials were used (e.g., dredged clean sandy materials piped in or barged in from a nearby off-site source).

6.4.2.2 Land Use

The proposed action would not alter the existing land use of the Bayville Abandoned Lagoon site. The site is owned by the Ocean County Natural Lands Trust and is maintained in a semi-natural state; this would remain unchanged after implementation of the project.

6.4.2.3 Fish and Wildlife

The proposed action is anticipated to have only minor, temporary impacts on aquatic wildlife within the Bayville lagoon, resulting from potential turbidity during filling operations. No long-term negative impacts are anticipated as a result of the proposed action. On the contrary, restoring habitats closer to average conditions in undisturbed areas of Barnegat Bay would likely increase populations of fish and benthos at this site. Greater numbers of fish and benthos at this site could also provide additional foraging opportunities for piscivorous birds, fish, and other wildlife. In addition, the shallower conditions resulting from the project will allow for establishment of new areas of SAV. These new habitats will directly benefit dabbling waterfowl such as black duck.

Deposition of clean, sandy material in the lagoon will cause a temporary increase in turbidity and suspended materials. These materials could decrease visibility, impacting the ability of some fish to visually acquire prey or avoid threats. They are, however, unlikely to cause physical impacts since fish are highly mobile and will avoid such disturbances by temporarily relocating to an undisturbed habitat. Given the poor water quality and bottom substrate existing at the lagoon, it is unlikely that either fish eggs, larvae, or a significant number of benthos utilize this habitat; short-term impacts are therefore expected to be relatively minor. These impacts are expected to be rapidly offset as fish and benthos move into newly restored habitat. Because better quality habitat will be available after placement, the restored habitat is expected to support a greater diversity and density of fish and benthos. The proposed action could improve habitat for important commercial and recreational fishery resources such as winter flounder, blue crabs, bluefish, Atlantic menhaden, striped bass, and others.

The proposed action is also anticipated to pose only minor, temporary impacts on terrestrial wildlife. Several areas of the existing berms would have to be cleared of their existing scrubby upland vegetation, in preparation for material removal (for lagoon fill). The existing vegetation on the berms consists of a mixture of very small trees and shrubs. Most of the important terrestrial wildlife, such as sharp-tailed sparrow, marsh wren, American egret, and snowy egret, were observed in the existing tidal marsh adjacent to the site. These species are highly mobile and would only be temporarily and indirectly disturbed during implementation of the project. Owing to its scrubby nature, very few terrestrial wildlife species were observed on the upland berm habitats during numerous field visits to the site (Harriott and Southerland 2001). Impacts to these species as a result of the project, therefore, will likely be minimal.

No adverse effects to the adjacent mapped EFH are anticipated. The lagoon fill material will come directly from the existing upland sandy berms at the site. On the contrary, the proposed action would connect the lagoon to the Bay, and create 4.79 acres of ideal new fish and benthic habitats that are very likely to improve conditions for EFH species of concern.

6.4.2.4 Vegetation and Land Cover

Portions of the existing 8.44 acres of the existing upland deciduous forest berm habitat would be affected by the proposed action. It has not yet been determined what specific areas of the berms would be used as borrow material for bottom-raising of the lagoon. The existing scrubby upland forest vegetation will be cleared from all sections of the berms to be used, and the sandy material will be removed where appropriate. In addition, an area of approximately 0.21 acre of the existing upland forest vegetation would be lost owing to the creation of the northeastern channel.

As previously noted (Harriott and Southerland 2001) the berms and their upland vegetation have only been in place for about 30 years, and are essentially a man-made, non-native habitat type on what was historically natural tidal marsh. There is no current evidence that the berms represent valuable habitats to nesting birds or other native wildlife. Finally, not all areas of the berms will need to be cleared; other upland berm habitats will remain unaffected. It is likely that woody vegetation will recolonize the excavated berms in places that remain well-drained.

In addition, approximately 0.96 acres of phragmites marsh (in two locations) and 0.21 acres of tidal marsh would be affected by the new channel creation for the proposed action. A small part of the affected tidal marsh would be directly converted to shallow open water channel habitat; the other part would only be affected by additional tidal flooding. The existing phragmites marsh would also be affected in two ways. Part of it would be directly converted to shallow open water channel habitat; the other part would be affected by tidal flooding. It is likely that the new tidal flooding will convert these phragmites habitats adjacent to the new channels to tidal marsh vegetation (i.e., *Spartina* spp.). The two new proposed channels were placed in their specific locations to focus channel-related impacts to lesser-value phragmites marsh (as opposed to tidal marsh). Considering the clear ecological benefits of implementing the proposed action, the loss of the small quantity of tidal marsh and phragmites marsh is minimal.

Earth-moving equipment necessary for the clearing and material removal work on the berms may access the site via the existing dirt road, or from the water by boat or barge. Proper use of soil erosion and sediment control techniques and best management practices during all material removal and material flattening operations will also help to minimize both terrestrial and aquatic impacts.

6.4.2.5 Threatened and Endangered Species

According to the New Jersey Natural Heritage database, and USFWS, there are no records of state or Federal threatened or endangered species or other species of special concern on the Bayville Abandoned Lagoon site. No listed threatened or endangered species or other species known to be of special concern were observed during the environmental testing field studies. Therefore, no adverse impacts are anticipated.

6.4.2.6 Wetlands

As mapped in the Barnegat Bay Ecosystem Restoration Environmental Testing and Restoration Proposals (Harriott and Southerland 2001), a total of approximately 21.14 acres of freshwater and tidal wetlands exist at the Bayville Abandoned Lagoon site. Creation of the two channels to implement the proposed action will directly impact a small quantity of the existing phragmites marsh (0.98 acre) and a very small quantity of existing tidal marsh (0.21 acre). The exact location of the proposed channels has been carefully considered, however, to minimize overall ecological impacts. Both channels will be cut through previously disturbed areas that are dominated by dense, monotypic stands of phragmites. Through careful location of the proposed channels, impacts to tidal marsh have been minimized. The two small areas of affected tidal marsh that would be impacted by creation of the southwestern channel are directly adjacent to the dense phragmites. Creation of the two channels will not only provide circulation in the lagoon with all of its ecological benefits, but the tidal saline Bay water will also serve to naturally remove some of the phragmites that is directly adjacent and convert it to a combination of tidal marsh and shallow open water. The combined benefits to fisheries, benthos, dabbling waterfowl, and other key biota will outweigh the small adverse effects to existing disturbed wetlands at the Bayville Abandoned Lagoon site. There will be no net loss of wetlands as a result of the project. For these reasons overall adverse effects to existing vegetated wetlands will be minimal.

6.4.2.7 Air Quality

In the short-term, employee vehicles and construction equipment will cause a temporary increase in emissions of volatile organic compounds, nitrogen oxides, sulfur dioxide, and carbon monoxide. Emissions produced during construction are not expected, however, to exceed ambient air quality standards for the area. No long-term impacts to local air quality are expected from the proposed action; therefore no adverse effects are anticipated.

6.4.2.8 Hazardous and Toxic Materials

Existing data base information (as well as site observations during the ecological testing field studies) suggests little potential for encountering hazards on the Bayville Abandoned Lagoon site. Of note, however, the data indicate that one adjacent site (within 1/8 mile), owned by AT&T, is classified as "Small Quantity Generator" of hazardous materials. This information, however, indicates there are no records of violations, spills, or any problems at the site. It is not known at this time what the nature of the materials is at this adjacent site. In addition, EDR mapped three other sites within ½ to 1 mile of the Bayville Abandoned Lagoon site. These three sites are relatively far from the Bayville Abandoned Lagoon site, and appear to be only associated with several minor spills. Because of the nature of the proposed restoration, it does not appear likely that these four adjacent sites are likely to be affected by the proposed restoration. Therefore, no adverse effects relating to hazardous and toxic materials are anticipated as a result of the proposed action.

6.4.2.9 Water Resources

Surface water quality will be improved as a result of the proposed action. Dissolved oxygen levels will be increased in this lagoon as a result of decreasing the average depth to 6 feet, and by increasing circulation. It will be directly connected to the Bay via two new channels. The existing circulation in the Bayville Abandoned Lagoon is poor; connecting it to the Bay via the two new channels will greatly improve this condition. Daily tidal flushing will likely maintain higher dissolved oxygen levels in the lagoon in the warm months, despite the new shallower conditions. The improved water quality in the lagoons and increased shallowness will provide much better habitats for native fish, benthos, and dabbling waterfowl such as black duck. Therefore, no adverse effects relating to water resources are anticipated as a result of the proposed action.

6.4.2.10 Geology and Soils

Areas of the existing sandy berms would be excavated for use as clean fill material in the lagoon; smaller areas of the existing phragmites marsh, tidal marsh, and upland deciduous forest will be excavated to create the two inlet/outlet channels. Materials excavated from the phragmites marsh, tidal marsh, and upland deciduous forest will be deposited in the lagoon to give it an overall depth of 6 feet. As previously indicated, not all areas of the berms would be excavated; these areas will remain intact. It should be noted that these berms are man-made and artificial; they are not representative of the local topography (essentially very flat tidal marsh and open water). Even though the existing substrate of the phragmites marsh, tidal marsh, and upland deciduous forest (i.e., berms) will be excavated for creation of the two channels, the proposed action is relatively small in the perspective of the large quantity of existing marsh. No adverse effects relating to native geology and soils, therefore, are anticipated as a result of the proposed action.

6.4.2.11 Recreational Resources

It is assumed that vehicle access to the Bayville Abandoned Lagoon site will remain blocked by a locked gate; access will be by foot only from Bayview Avenue. There are no existing recreational facilities established on the Bayville Abandoned Lagoon site. The existing fishing and hunting uses in the areas adjacent to the site will presumably remain unchanged after the project is implemented. Boat access using the new tidal connections will be limited by barriers incorporated into the project design; access via the northeastern channel will be blocked by a road culvert. It is therefore presumed that recreational aspects of the Bayville Abandoned Lagoon will remain unchanged by the proposed action; no adverse effects, therefore, are anticipated.

6.4.2.12 Cultural Resources

A preliminary review of the information provided for this project area indicates a fairly low probability for the presence of archaeological sites. This project site is located in low lying area that has been subjected to flooding, erosion, and extensive previous construction activity.

Consultation with the NJ SHPO is continuing and will be concluded prior to any construction activity.

Bayville Abandoned Lagoon project area is located in low tidal marsh areas. In the project area, deep channel lagoons were excavated entirely from native tidal marsh deposits by developers in the 1960's and abandoned. Proposed connecting channel excavation in tidal marsh deposits and lagoon filling from adjacent backdirt piles created when the lagoon was initially dug will have no impact on cultural resources.

6.4.2.13 Socioeconomic Resources

No socioeconomic impacts are anticipated.

6.4.2.14 Aesthetic/Visual Resources

Excavation of some areas of the berms at the Bayville Abandoned Lagoon may affect the viewshed. Such effects are likely, however, to be positive overall. Use of material from the large fill pile at the end of the existing dirt road would provide for increased views of the adjacent tidal marsh and the Bay from the dirt road and potentially from the lagoon. Use of too much material from the large rectangular pile to the immediate north of the lagoon, however, could open views to car traffic on Bayview Avenue. This potential effect could be relatively easily avoided by leaving an adequate vegetated buffer between the road and the site. The overall aesthetic effect of the new viewsheds would be improved by implementation of the proposed action. No adverse effects to aesthetic/visual resources are anticipated as a result of the proposed action.

6.4.2.15 Cumulative Impacts

Cumulative impacts may arise when the effects of individual actions that are not significant combine with the effects of other past, present, or reasonably foreseeable future actions (regardless of who undertakes these actions) to produce significant effects on resources. Whether adverse cumulative impacts are significant depends on the magnitude and extent of the effects and the capacity of the resources to withstand these effects.

Under the proposed action, restoration activities at Bayville Abandoned Lagoon will benefit the biological resources and ecological condition of the Barnegat Bay ecosystem. When combined with other actions in the vicinity, these activities will augment environmental improvements or, at a minimum, slow degradation effects. No activities associated with the proposed action will contribute to adverse cumulative impacts.

6.4.3 Oyster Creek

6.4.3.1 Physical Setting

The proposed action under Alternative 3 would not adversely affect the existing physiography and topography of the Oyster Creek site. The approximately 65,500 cubic yards of materials

excavated from the new channels would be placed in an area of the site that is already primarily open sand and upland phragmites. This area would be slightly raised and would be flattened to the greatest degree possible in preparation for creation of new diamondback terrapin habitat. Therefore, impacts on physiography and topography would likely be minimal.

6.4.3.2 Land Use

The proposed action would alter the existing land use of the Oyster Creek site. The site is privately owned by Amergen Energy Company and was used in the past for dredged material disposal. Subsequent to construction the restoration site would be maintained in a semi-natural state; this would permanently preclude further material disposal on the site. Remaining areas adjacent to, but not on, the restoration site may be used in the future by Amergen Energy Company or other entities for disposal of dredged material.

6.4.3.3 Fish and Wildlife

In its current state, the Oyster Creek site constitutes a large, dense phragmites marsh with little apparent habitat value for terrestrial or aquatic wildlife. The proposed action will create both native tidal marsh and open water habitats, and is therefore anticipated to have a major positive impact on the diversity and number of terrestrial and aquatic wildlife at the site. No long-term negative impacts are anticipated as a result of the proposed action.

Creation of the channel system at the Oyster Creek site will likely cause a temporary increase in turbidity and suspended materials in Oyster Creek and the Bay adjacent to the site. These materials could decrease visibility, impacting the ability of some fish to visually acquire prey or avoid threats. They are, however, unlikely to cause physical impacts since fish are highly mobile and will avoid such disturbances by temporarily relocating to an undisturbed habitat. Further, these waters are tidal; it is likely the suspended material will be dissipated fairly quickly.

Several of the terrestrial wildlife species listed for the Oyster Creek site were observed along the system of upland dirt paths around the site. Species such as white-tailed deer, northern black racer snake and black rat snake, observed on the paths, do not readily use the dense phragmites habitats present on site. It is not likely these species would be affected by the proposed action. White-tailed deer and other large mammals have an abundant, nearby off-site source of fresh water to the immediate north and west of the site. The off-site area possesses a system of grid ditches that appear to have permanent, easily accessible fresh water. Other species observed at the site, such as osprey, mute swan, and spotted sandpiper will find greatly enhanced feeding opportunities as a result of the proposed action.

No adverse effects to the adjacent mapped EFH are anticipated. Material excavated from the new system of tidal channels will be deposited in an adjacent upland location for diamondback terrapin habitat. On the contrary, the proposed action will create a large system of shallow open water channels with adjacent tidal marsh habitats, similar to natural tidal creeks in the region; the project will likely to improve overall conditions for EFH species of concern.

6.4.3.4 Vegetation and Land Cover

Approximately 18.31 acres of the existing phragmites marsh would be converted to tidal marsh, and 5.22 acres of scrub/shrub-phragmites and 4.92 acres of open sand/beach heather (10.14 acres) would be converted to open, sandy diamondback terrapin habitats. The existing phragmites marsh is composed of dense, monotypic stands of phragmites; it is therefore considered to be of low overall ecological and habitat value. Tidal marsh and open water channel habitat that will replace the phragmites marsh will be of much greater habitat value to critical species such as sharp-tailed sparrow, seaside sparrow, and marsh wren. Therefore, no adverse impacts are anticipated.

6.4.3.5 Threatened and Endangered Species

The New Jersey Natural Heritage database indicated that records exist for one plant, awned mountain mint (*Pycnanthemum setosum*) on or near the Oyster Creek site. This species is not Federal or state listed, but has been assigned a state ranking indicating that it is imperiled in the state because of the small number of known occurrences (6 to 20). It is apparently also relatively rare throughout the rest of its natural range. According to the Heritage records, awned mountain mint was observed on or near the Oyster Creek site in 1993. This species was not observed at the Oyster Creek site during the Barnegat field studies. Prior to the implementation of a final restoration design, the existing populations of awned mountain mint must be thoroughly assessed on this site (if they indeed exist) so they can be avoided and protected. Owing to the specific nature of the proposed action, it is likely that awned mountain mint, if it indeed exists at the site, can be easily avoided. This is a plant with upland habitat preferences and would likely occur on the system of pathways that exist at the site, not in the phragmites marsh where the actual work will take place. Therefore, no adverse impacts to awned mountain mint are anticipated.

USFWS recently indicated that an extant population of the Federal candidate and state-listed endangered bog asphodel (*Narthecium americanum*) is located within one mile of the Oyster Creek site (USFWS 2002). No appropriate habitat apparently exists on or adjacent to the Oyster Creek site, however, for this species. Therefore, no adverse impacts to bog asphodel are anticipated.

6.4.3.6 Wetlands

As mapped in the Barnegat Bay Ecosystem Restoration Environmental Testing and Restoration Proposals report (Harriott and Southerland 2001), a total of approximately 99.36 acres of wetlands currently exist at the Oyster Creek site. Two-thirds of the Oyster Creek site consists of dense, monotypic phragmites marsh. A total of 18.31 acres of nontidal phragmites marsh would be impacted by the proposed action; it would be replaced by a system of shallow tidal open water channels with margins of tidal marsh dominated by cordgrasses. There will be no net loss of wetlands as a result of the project. Considering the fact that the existing phragmites marsh comprises relatively poor wildlife habitat, and that it would be replaced by more valuable habitat for a variety of native wildlife, overall adverse effects to existing vegetated wetlands are considered minimal.

6.4.3.7 Air Quality

In the short-term, employee vehicles and construction equipment will cause a temporary increase in emissions of volatile organic compounds, nitrogen oxides, sulfur dioxide, and carbon monoxide. Emissions produced during construction are not expected, however, to exceed ambient air quality standards for the area. No long-term impacts to local air quality are expected from the proposed action; therefore no adverse effects are anticipated.

6.4.3.8 Hazardous and Toxic Materials

Existing data base information (as well as site observations during the ecological field studies) suggests little potential for encountering hazards on the Oyster Creek site. The data also indicate that there are no potential hazards on any directly adjacent properties. Several records of minor, residential-related spills (e.g., one spill of several gallon of hydraulic oil; another minor spill of gasoline) apparently exist within one-quarter mile of the site. These mapped "contaminated" sites are not likely to have any negative effect on the proposed restoration. Therefore, no adverse effects relating to hazardous and toxic materials are anticipated as a result of the proposed action.

6.4.3.9 Water Resources

The existing surface water resources at the Oyster Creek site (several small ponds and large ditches) are isolated, shallow, poorly-flushed, and likely possess poor quality habitat for wildlife. As a result of the proposed action, these water resources would be connected to the tidal waters of the Bay via a braided system of new channels with two outlets/inlets to the adjacent Oyster Creek and the Bay. The braided channels will provide a large quantity of new, high-quality water resources. A variety of native wildlife will be attracted to the new water resources and tidal marsh that will be created by the proposed action. Therefore, no adverse effects relating to water resources are anticipated as a result of the proposed action.

6.4.3.10 Geology and Soils

All of the substrate to be excavated for creation of the proposed system of intertidal channels at the Oyster Creek site is dredged material; no native soils are likely to be disturbed. Excavated materials will be placed in the western part of the site on an existing largely unvegetated upland area containing only dredged materials. No adverse effects relating to native geology and soils, therefore, are anticipated as a result of the proposed action.

6.4.3.11 Recreational Resources

The Oyster Creek site is privately owned and is currently prominently posted with "no trespassing" signs along its entire boundary with Orlando Drive. Current recreation, including motorcycle riding, campfires, and partying at the site is likely without permission and, therefore, illegal. To ensure success of the mitigation (particularly for diamondback terrapin habitats) and for public safety, such activities should continue to be discouraged. Other potential activities, such as wildlife viewing from canoes, kayaks, and small boats may be possible in the system of

new channels, although access may be limited at low tide in many areas. Boat access using the new tidal connections will be limited by barriers incorporated into the project design**.** No adverse effects to recreational resources are anticipated as a result of the proposed action.

6.4.3.12 Cultural Resources

A preliminary review of the information provided for this project area indicates a fairly low probability for the presence of archaeological sites. This project site is located in low lying area that has been subjected to flooding, erosion, and extensive previous construction activity. Consultation with the NJ SHPO is continuing and will be concluded prior to any construction activity.

Oyster Creek project area is low lying marsh area that has been used for the disposal of dredged material within the last 20 years (see site description in Section 3.3). Substrate corings taken throughout the project site and other measurements indicate that the depth of fill ranges from 2 to 11 feet above pre-disposal marsh deposits. The proposed excavation of a meandering and braided open channel system will be restricted to these fill deposits, which have no potential for significant cultural resources.

6.4.3.13 Socioeconomic Resources

No socioeconomic impacts are anticipated.

6.4.3.14 Aesthetic/Visual Resources

Creation of the new intertidal channel system will improve aesthetic/visual resources at the Oyster Creek site. The existing viewshed in the majority of the site is impeded by dense, tall phragmites. The habitats in the immediate vicinity of the new channels will comprise open water and tidal marsh; these new habitats should be much more aesthetically appealing than the existing phragmites marsh. The existing aesthetically pleasing views of Oyster Creek and Barnegat Bay from parts of the southeastern areas of the site would not be affected by the proposed action. No adverse effects to aesthetic/visual resources are anticipated as a result of the proposed action.

6.4.3.15 Cumulative Impacts

Cumulative impacts may arise when the effects of individual actions that are not significant combine with the effects of other past, present, or reasonably foreseeable future actions (regardless of who undertakes these actions) to produce significant effects on resources. Whether adverse cumulative impacts are significant depends on the magnitude and extent of the effects and the capacity of the resources to withstand these effects.

Under the proposed action, restoration activities at Oyster Creek will benefit the biological resources and ecological condition of the Barnegat Bay ecosystem. When combined with other actions in the vicinity, these activities will augment environmental improvements or, at a

minimum, slow degradation effects. No activities associated with the proposed action will contribute to adverse cumulative impacts.

6.4.4 Barnegat Lighthouse

6.4.4.1 Physical Setting

The proposed action under Alternative 4A would not adversely affect the existing physiography and topography of the Barnegat Lighthouse site. The approximately 67,200 cubic yards of materials excavated from the new channels would be deposited in designated, appropriate areas on the site. Therefore, impacts on physiography and topography would likely be minimal.

6.4.4.2 Land Use

The proposed action would not alter the existing land use of the Barnegat Lighthouse site. The site is owned by NJDEP and is part of Barnegat Lighthouse State Park; the proposed action would not alter any of the existing land uses within or adjacent to the park.

6.4.4.3 Fish and Wildlife

The proposed action is anticipated to have only minor, temporary impacts on aquatic wildlife in the flooded area behind the south jetty, resulting from potential turbidity during excavation operations for the pond. No long-term negative impacts are anticipated as a result of the proposed action.

Creation of the new pond at the Barnegat Lighthouse site will likely cause a temporary increase in turbidity and suspended materials in the adjacent area behind the south jetty. These materials could decrease visibility, impacting the ability of some fish to visually acquire prey or avoid threats. They are, however, unlikely to cause physical impacts, since fish are highly mobile and will avoid such disturbances by temporarily relocating to an undisturbed habitat. Further, these waters are tidal and the excavated material is sand; it is likely the suspended material will dissipate fairly quickly.

It is not likely that any terrestrial wildlife will be negatively impacted by the proposed action. All of the terrestrial species noted at the site were birds (Harriott and Southerland 2001). All of the shorebirds noted at the site, including piping plover, semipalmated plover, sanderling, least sandpiper, spotted sandpiper, and least tern, would likely benefit from the proposed action, because new intertidal feeding habitats would be created. Because of their different feeding habits and larger ranges, other species such as laughing gull, greater black-backed gull, herring gull, common tern, Forster's tern, and osprey would not likely be either positively or negatively affected by the proposed action.

No adverse effects to the adjacent mapped EFH are anticipated. Material excavated from the small shallow intertidal pond will likely be deposited on an area of low dunes adjacent to the site. Because of the small size of the project at Barnegat Lighthouse, the proposed action is not likely to either benefit or adversely affect EFH.

6.4.4.4 Vegetation and Land Cover

Approximately 5.03 acres of the existing upland dune community, 1.52 acres of upland phragmites, and 0.17 acre of beach habitat would be affected by the proposed action. These three existing land cover types would be replaced by a shallow intertidal pond land cover type. It is certain that the new pond land cover type will provide superior habitats for critical species such as piping plover, least tern, and other shorebirds that feed in these conditions. Therefore, no adverse impacts are anticipated.

6.4.4.5 Threatened and Endangered Species

The New Jersey Natural Heritage database indicated that records exist for piping plover (*Charadrius melodus*) and least tern (*Sterna antillarum*) in the vicinity of the Barnegat Lighthouse site. Piping plovers are listed as Federal threatened and New Jersey endangered. They are considered to be somewhat rare throughout their natural range, and their breeding populations are considered critically imperiled in New Jersey; they are, however, apparently secure in other parts of their natural range. It is the opinion of experts at the NJDEP Division of Fish and Wildlife and USFWS that the proposed action would greatly benefit these two species, as well as a variety of other shorebirds. Therefore, no adverse impacts are anticipated.

USFWS, in a letter dated 26 October 2002, recommended that a survey be conducted prior to construction to ascertain whether seabeach amaranth (*Amaranthus pumilis*) exists at the site. Said survey will be completed prior to construction, and USACE will contact USFWS if the species is found at this location.

6.4.4.6 Wetlands

As mapped in the Barnegat Bay Ecosystem Restoration Environmental Testing and Restoration Proposals report (Harriott and Southerland 2001), a total of approximately 20 acres of open water wetlands and roughly 5 acres of phragmites wetlands currently exist at the Barnegat Lighthouse site. These wetlands comprise unvegetated open water habitats and vegetated phragmites habitats. None of these open water habitats would be permanently impacted by the proposed action. Only 0.07 acre of adjacent unvegetated beach would be affected by the proposed action. This small area of beach would be replaced by a pair of open channels that would serve as inlets for the small intertidal pond. Considering this very small impact, along with the fact that the beach is a dynamic, ever-changing system, overall adverse effects to wetlands are considered minimal.

6.4.4.7 Air Quality

In the short-term, employee vehicles and construction equipment will cause a temporary increase in emissions of volatile organic compounds, nitrogen oxides, sulfur dioxide, and carbon monoxide. Emissions produced during construction are not expected, however, to exceed ambient air quality standards for the area. No long-term impacts to local air quality are expected from the proposed action; therefore no adverse effects are anticipated.

6.4.4.8 Hazardous and Toxic Materials

Existing data base information (as well as site observations during the ecological field studies) suggests little potential for encountering hazards on the Barnegat Lighthouse site. The data also indicate that there are no potential hazards on any directly adjacent properties. Several records of minor, primarily residential-related spills were mapped by EDR within one-quarter mile of the site. These mapped "contaminated" sites are not likely to have any negative effect on the proposed restoration. Therefore, no adverse effects relating to hazardous and toxic materials are anticipated as a result of the proposed action.

6.4.4.9 Water Resources

Because of the nature of the proposed action (i.e., create a small intertidal pond from a low dune), existing water resources would only be temporarily affected. Two small, open-channels leading to the flooded area behind the south jetty will serve as the inlets/outlets for the new intertidal pond. Construction of the inlet/outlet could cause temporary sedimentation in the flooded area behind the south jetty, but these effects are expected to subside very quickly after construction. The materials to be excavated are all sand; any escaping material will be removed quickly by the tide. The proposed intertidal pond would create new surface water habitats on the site; the pond would be highly beneficial to piping plover, least tern, and other formally listed threatened and endangered birds. Therefore, no adverse effects relating to water resources are anticipated as a result of the proposed action.

6.4.4.10 Geology and Soils

As a result of the proposed action, approximately 67,200 cubic yards of native sand would be excavated for creation of a 5.5-acre intertidal pond. The excavated sand will be used for dune building on the low area of essentially unvegetated sand to the northwest of the proposed pond. It should be noted that this site is within an extremely dynamic system because of its proximity to the Atlantic Ocean, Barnegat Bay, and Barnegat Inlet. Local topography is changed to a minor degree during regular storm events and to a large degree during major storms. The site has also been significantly disturbed recently during construction of the south jetty and other man-made actions. Put in this perspective, no adverse effects relating to native geology and soils are anticipated as a result of this relatively small proposed action. No adverse effects relating to native geology and soils, therefore, are anticipated as a result of the proposed action.

6.4.4.11 Recreational Resources

To protect the new piping plover habitats during the breeding season, the site will likely be fenced, limiting access by humans and their pets. The location of the proposed intertidal pond is on the lower vegetated portion of the existing dune where no footpaths currently exist; little recreation currently occurs here. Some views of the pond will be possible from the perimeter of the fence for viewing of birds and other wildlife. The new inlet channels will be bridged at the beach northeast of the pond, so pedestrian and emergency vehicle access will continue

unimpeded. No adverse effects to recreational resources are anticipated as a result of the proposed action.

6.4.4.12 Cultural Resources

A preliminary review of the information provided for this project area indicates a fairly low probability for the presence of archaeological sites. This project site is located in low lying area that has been subjected to flooding, erosion, and extensive previous construction activity. Consultation with the NJ SHPO is continuing and will be concluded prior to any construction activity.

Barnegat Lighthouse project area has been extensively disturbed by previous activity associated with the construction of the Barnegat Inlet channel and new south jetty. The proposed excavation of a 5 acre pond and 2 tidal water inlet connecting channels will have no impact on cultural resources. The project area has been severely altered by previous inlet erosion, jetty construction and dredged material placement. The Barnegat Lighthouse, a National Register listed property, is located immediately north of the project area and will not be impacted by proposed construction.

6.4.4.13 Socioeconomic Resources

No socioeconomic impacts are anticipated.

6.4.4.14 Aesthetic/Visual Resources

The new shallow intertidal pond created as part of the proposed action would likely be aesthetically pleasing. It is not clear at this time how much of the pond would be visible to the adjacent residents of Barnegat Light. It is likely, however, that the pond will have a natural appearance and will provide an aesthetically appealing ground-level view. No adverse effects to aesthetic/visual resources are anticipated as a result of the proposed action.

6.4.4.15 Cumulative Impacts

Cumulative impacts may arise when the effects of individual actions that are not significant combine with the effects of other past, present, or reasonably foreseeable future actions (regardless of who undertakes these actions) to produce significant effects on resources. Whether adverse cumulative impacts are significant depends on the magnitude and extent of the effects and the capacity of the resources to withstand these effects.

Under the proposed action, restoration activities at Barnegat Lighthouse will benefit the biological resources and ecological condition of the Barnegat Bay ecosystem. When combined with other actions in the vicinity, these activities will augment environmental improvements or, at a minimum, slow degradation effects. No activities associated with the proposed action will contribute to adverse cumulative impacts.

6.4.5 Stafford Forge

6.4.5.1 Physical Setting

The proposed action under Alternative 7 would not significantly alter the existing terrestrial topography of the Stafford Forge site. Only two small spillways would be cut from the existing man-made berms.

6.4.5.2 Land Use

The proposed action would not alter the existing land use of the Stafford Forge site. The site is owned by the NJDEP and is maintained in a semi-natural state for fishing, hunting, and other recreational uses; these uses would remain unchanged after implementation of the project.

6.4.5.3 Fish and Wildlife

The plan for this site includes installing one fish & eel passage, refurbishing two culvert systems, refurbishing water control structures, and installing three water control structures. The proposed action would have only minor, temporary impacts on aquatic wildlife in the areas immediately downstream of the construction sites, resulting from potential turbidity caused by these activities. Aquatic wildlife currently using Ponds 2, 3, and 4 (all off-line from Westecunk Creek), particularly native fish, however, could be affected by lowering the water levels to an average depth of 18 inches. The ponds will be made shallow, permitting establishment of rooted emergent wetland vegetation and SAV; seasonal temperatures would be warmer and dissolved oxygen would likely be lower.

It is apparent, however, that these ponds do not currently support a rich fishery. This has also been confirmed by the NJDEP Division of Fish and Wildlife (Harriott and Southerland 2001). The apparent lack of fish in these ponds is supported by the fact that relatively few piscivorous birds (e.g., egrets, herons, etc.) have been observed on these ponds during numerous site visits over all seasons. In addition, no anglers have been observed fishing these ponds over many visits to the site. Given that existing conditions at Ponds 2, 3, and 4 likely include a relatively poor fishery, and that the potential for creation of excellent dabbling waterfowl habitat is great, effects to these resources are relatively minor. The small number of existing predatory fish, such as grass pike and small mouth bass would likely decrease in numbers, but other species such as sunfish (more tolerant of shallow, warm waters) would not likely be affected.

Addition of the fish ladder, refurbishment of the two culverts, and creation of the new earthen spillways at the Stafford Forge site will likely cause a temporary increase in turbidity and suspended materials in the adjacent areas. These materials could decrease visibility, impacting the ability of some fish to visually acquire prey or avoid threats. They are, however, unlikely to cause physical impacts since fish are highly mobile and will avoid such disturbances by temporarily relocating to an undisturbed habitat.

It is not likely that terrestrial wildlife will be negatively impacted by any aspect of the proposed action at Stafford Forge.

6.4.5.4 Vegetation and Land Cover

Owing to the nature of the project, terrestrial vegetation and land cover would not be affected by the proposed action. A total of 70.86 acres of open water/stream habitat would be made much shallower overall, creating a mixture of emergent marsh and shallow open water. There will be no other changes to vegetation and land cover relating to the proposed action. Therefore, no adverse impacts are anticipated.

6.4.5.5 Threatened and Endangered Species

The New Jersey Natural Heritage database indicated that recent records exist for one plant, Knieskern's beaked rush (*Rhynchospera knieskernii*), on the site. In addition, the records cited two animals, pine barrens tree frog (*Hyla andersonii*) and Cooper's hawk (*Accipiter cooperii*), as present at the site. Knieskern's beaked rush was observed in 1994 adjacent to the northern-most pond (Pond 1); this species is listed as Federal threatened and state endangered, and is extremely rare throughout its entire naturally occurring range. Pine barrens tree frog was apparently recorded in several locations within Stafford Forge in 1990; this species is listed as state endangered, but is apparently secure throughout other parts of its naturally occurring range. One pair of nesting Cooper's hawks were recorded in 1995 within Stafford Forge, along Old Forge Road to the north of the northernmost bog; this species is listed as state threatened, but is secure within other parts of its naturally occurring range. No additional data are currently available on the status of these species at Stafford Forge. None of these species were observed on numerous visits to the site during the field studies.

Prior to the implementation of a final restoration design, the existing populations of Knieskern's beaked rush must be thoroughly assessed on this site (if the species indeed still exists here) so they can be avoided and protected. Owing to its apparently remote location adjacent to Pond 1, the fact that the pond would be maintained at its current water level, and that work would be restricted to very small areas of the existing berm on the south end of the pond, it is not likely Knieskern's beaked rush would be adversely affected by the proposed action. It is also not likely that pine barrens tree frog would be adversely affected by the proposed action. On the contrary, the black duck habitat component of the project could even improve conditions for the existing pine barrens tree frogs. By lowering the water levels in Ponds 2, 3, and 4 to an average depth of 18 inches, it is likely that some areas of woody vegetation (shrubs and trees) will develop along the outer edges of the ponds, providing additional potential habitats for the tree frogs directly above (or adjacent to) the water. It not likely that the new areas would be appropriate breeding habitats for pine barrens tree frogs; fish will probably still reside in these areas. Finally, because of the nature of the project, it is not likely that Cooper's hawk would be adversely affected by the proposed action. In addition, no nesting pairs of Cooper's hawks have apparently been recorded at the site for about 7 years. No aspect of the proposed action would affect future use of the site by these or other raptors. Therefore, it is not likely that the proposed action would adversely affect Cooper's hawk.

6.4.5.6 Wetlands

As mapped in the recent Barnegat Bay Ecosystem Restoration Environmental Testing and Restoration Proposals report (Harriott and Southerland 2001), a total of approximately 321 acres of wetlands currently exist at the Stafford Forge site. No existing wetlands will be adversely affected by the proposed action. The proposed fish ladder and eel passage facility will be constructed as part of the existing downstream water control structure and concrete spillway on Pond 5; existing flow regimes in Westecunk Creek would be maintained. Further, refurbishing of the two upstream culverts (one on Westecunk Creek adjacent to Pond 2, the other on Pond 1) could be easily accomplished from the existing dirt access roads. Finally, the earthen spillways for lowering the water levels in Ponds 2, 3, and 4 would be constructed directly in the existing upland berms. The deepwater conditions in Ponds 2, 3, and 4 would be converted to shallow habitats with an average depth of about 18 to 22 inches. The new conditions will convert these ponds to emergent wetlands interspersed with shallow open water and SAV habitats. It is certain that these new habitats would be of much greater overall ecological value than the existing deepwater habitats. Therefore, there would be no overall adverse impacts to wetlands as a result of the proposed action.

6.4.5.7 Air Quality

In the short-term, employee vehicles and construction equipment will cause a temporary increase in emissions of volatile organic compounds, nitrogen oxides, sulfur dioxide, and carbon monoxide. Emissions produced during construction are not expected, however, to exceed ambient air quality standards for the area. No long-term impacts to local air quality are expected from the proposed action; therefore no adverse effects are anticipated.

6.4.5.8 Hazardous and Toxic Materials

Existing data base information (as well as site observations during the ecological field studies) suggests little potential for encountering hazards on the Stafford Forge site. The data also indicate that there are no potential hazards on any directly adjacent properties. Two records for closed sanitary landfills were mapped within one mile of the Stafford Forge site (both sites on Stafford Forge Road). The data indicate that both were municipal landfills that are now closed. These two mapped closed landfill sites are not likely to have any negative effect on the proposed restoration at the Stafford Forge site. Therefore, no adverse effects relating to hazardous and toxic materials are anticipated as a result of the proposed action.

6.4.5.9 Water Resources

The anadromous and catadromous fishery habitat aspect of the proposed action (i.e., install one fish ladder and eel passage facility on an existing water control structure and refurbish two existing culverts) would have no effect on existing water resources. Existing water quality would not be affected. The black duck habitat aspect of the proposed action would convert Ponds 2, 3, and 4 from the existing relatively sterile, deep water habitats to shallow emergent marsh interspersed with small areas of shallow open water. Because SAV would likely exist in

some of the shallow open water areas (providing input of dissolved oxygen), and because the earthen spillways will provide flushing, water quality in these three ponds is anticipated to be very good.

6.4.5.10 Geology and Soils

Because of the nature of the proposed action, native geology and soils will not be affected. The two small earthen spillways to be created as part of the proposed action would be constructed directly in the existing man-made berms between Ponds 2 and 3. As no native soils would be disturbed, no adverse effects relating to native geology and soils are anticipated as a result of the proposed action.

6.4.5.11 Recreational Resources

It is likely that recreational opportunities could be improved at Stafford Forge as a result of the proposed action. Opening the Westecunk Creek system through the site will allow for passage of anadromous, catadromous, and other native fish. The unrestricted movement of these fish could improve opportunities for angling in the area. It would ultimately benefit the river herring and American eel populations in the Bay as a whole, enhancing recreational fishing opportunities in the region. In addition, the black duck habitat portion of the action would benefit dabbling waterfowl in the vicinity of Stafford Forge, and would in turn have a positive effect on site duck hunting opportunities and bird watchers. As all of the affected waterfowl are migratory, the project would have an overall benefit on the regional populations. No adverse effects to recreational resources are anticipated as a result of the proposed action.

6.4.5.12 Cultural Resources

A preliminary review of the information provided for this project area indicates a fairly low probability for the presence of archaeological sites. This project site is located in low lying area that has been subjected to flooding, erosion, and extensive previous construction activity. Consultation with the NJ SHPO is continuing and will be concluded prior to any construction activity.

Stafford Forge project area is the former site of a 527 acre cranberry bog now managed for wildlife by NJDEP. The site was used for cranberry production as recently as the 1960's. The site consists of a series of five large ponds with various wooden, metal and concrete water control structures. Proposed construction at the site includes the placement of a fish ladder at an existing water control structure at Pond #5, refurbishing an existing pipe culvert system and water control structures, and installing three new water control structures. Additional research is required to provide a history of the cranberry operation at the site and to determine the age and condition of related structural features in order to evaluate National Register eligibility.

6.4.5.13 Socioeconomic Resources

No socioeconomic impacts are anticipated.

6.4.5.14 Aesthetic/Visual Resources

Owing to the nature of the project, the anadromous fishery habitat portion of the proposed action will have little effect on the aesthetic/visual resources at Stafford Forge. The proposed fish ladder will be of timber construction to match the existing downstream water control structure and will be attached to the existing concrete spillway; it would have almost no effect on aesthetic/visual resources. The black duck habitat portion of the project will change the viewshed in the area of Ponds 2, 3, and 4 by converting the large open water areas to large, primarily vegetated areas of emergent marsh. This transformed appearance is likely to be viewed by the public as a welcome change from the existing large expanses of sterile open water in the ponds. In addition, the proposed action will increase the number of dabbling waterfowl and other birds for public viewing at these ponds.

6.4.5.15 Cumulative Impacts

Cumulative impacts may arise when the effects of individual actions that are not significant combine with the effects of other past, present, or reasonably foreseeable future actions (regardless of who undertakes these actions) to produce significant effects on resources. Whether adverse cumulative impacts are significant depends on the magnitude and extent of the effects and the capacity of the resources to withstand these effects.

Under the proposed action, restoration activities at Stafford Forge will benefit the biological resources and ecological condition of the Barnegat Bay ecosystem. When combined with other actions in the vicinity, these activities will augment environmental improvements or, at a minimum, slow degradation effects. No activities associated with the proposed action will contribute to adverse cumulative impacts.

6.4.6 Flat Island

6.4.6.1 Physical Setting

The proposed action under Alternative 3 would not adversely affect the existing physiography and topography of the Flat Island site. The approximately 55,700 cubic yards of materials excavated from the new channels would be placed in upland areas of the site that possess minimal woody vegetation (primarily upland phragmites with sparse woody vegetation). These areas would be slightly raised, but not to a significant degree. Therefore, impacts on physiography and topography would likely be minimal.

6.4.6.2 Land Use

The proposed action would partially alter the existing land use of the Flat Island site. The site is privately owned by Flat Islands Investors Corporation and was used in the past for dredged material disposal. Subsequent to construction, the restoration site would be maintained in a semi-natural state; this would permanently preclude further material disposal on the site. Remaining areas adjacent to, but not on, the restoration site may be used in the future by Flat

Islands Investors Corporation, NJDEP, USACE or other entities for disposal of dredged material. No adverse impacts to existing land use, therefore, are anticipated.

6.4.6.3 Fish and Wildlife

In its current state, the Flat Island site is clearly dominated by large areas of dense phragmites marsh that provide little to no habitat value for aquatic wildlife. The proposed action will create both native tidal marsh and open water habitats, and is therefore anticipated to have a major positive impact on the diversity and number of aquatic wildlife at the site. No long-term negative impacts are anticipated as a result of the proposed action.

Creation of the channel system at the Flat Island site will likely cause a temporary increase in turbidity and suspended materials in the Bay adjacent to the site. These materials could decrease visibility, impacting the ability of some fish to visually acquire prey or avoid threats. They are, however, unlikely to cause physical impacts since fish are highly mobile and will avoid such disturbances by temporarily relocating to an undisturbed habitat. Further, these waters are tidal; it is likely the suspended material will dissipate fairly quickly.

There are three small areas of upland scrub on Flat Island that possess large bayberry shrubs and scattered small trees. As reported in Harriott and Southerland (2001), parts of these upland areas were previously used by several species of long-legged wading birds as a minor coastal rookery in 1985. Recent visits to the site over several years, however, found no long-legged wading bird nests (several fish crow nests were observed). It is not definitively known why these habitats are no longer used for nesting by long-legged wading birds. There are several apparently active fox dens on the island, and it is possible these and other predators may have discouraged further nesting there. Some of the excavated clean, sandy materials from creation of the channel system would be deposited along the edges of these upland areas, away from mature woody vegetation (i.e., large shrubs and small trees). Upland vegetation will likely recolonize these peripheral areas relatively quickly, as there is a seed source directly adjacent. The most mature areas of vegetation would not be affected by the proposed action, and adverse effects to these resources will likely be minimal and temporary.

No adverse effects to the adjacent mapped EFH are anticipated. Material excavated from the new system of tidal channels will be deposited in an adjacent upland location that possesses little woody vegetation. On the contrary, the proposed action will create a large system of shallow open water channels with adjacent tidal marsh habitats, similar to natural tidal creeks in the region; the project will likely to improve overall conditions for EFH species of concern. No adverse effects to the existing SAV on the east side of the island are anticipated, as access to the project will be from the west side.

6.4.6.4 Vegetation and Land Cover

Approximately 10.08 acres of the existing phragmites marsh would be converted to tidal marsh. The existing phragmites marsh is composed of dense, monotypic stands of phragmites; it is therefore considered to be of low overall ecological and habitat value. Tidal marsh and open water channel habitat that will replace the phragmites marsh will be of much greater habitat

value to critical species such as sharp-tailed sparrow, seaside sparrow, and marsh wren. Therefore, no adverse impacts are anticipated.

6.4.6.5 Threatened and Endangered Species

The New Jersey Natural Heritage database indicated that records exist for seven species of concern, including snowy egret (*Egretta thula*), black-crowned night heron (*Nycticorax nycticorax*), little blue heron (*Florida caerulea*), Louisiana heron (*Hydranassa tricolor*), glossy ibis (*Plegadis falcinellus*), yellow-crowned night heron (*Nyctanassa violacea*), and northern harrier (*Circus cyaneus*) at Flat Island. The first five species (i.e., not including yellow-crowned night heron and northern harrier) were part of a minor coastal heron rookery that existed on the island in 1985. The Heritage record for yellow-crowned night heron was from nearly a decade earlier, in 1977. Northern harrier is not a colonial nesting species. No colonial nesting of any of these species currently occurs at the Flat Island site; none of these seven species were observed during the environmental testing field studies for the project (numerous trips were made to the site during all seasons of the year in 2000, 2001, and 2002). Only two fish crow nests were observed during the field studies.

It is possible that small areas of the existing woody vegetation at the site could be temporarily affected by the proposed action. A temporary staging area for large equipment will likely be required along the outer peripheries of one of the three upland scrub areas where the woody vegetation currently exists. In addition, it may be necessary to use a portion of the central upland scrub area for material disposal from the channel cutting. This upland area possesses the least amount of well-developed woody vegetation; no long-legged shorebirds (or other important avian species) currently nest in these upland scrub areas. It is anticipated that these aspects of the proposed action would be temporary; woody vegetation would be allowed to recolonize in these areas. It therefore would be theoretically possible for Flat Island to support long-legged shorebird colonial nesting again in the future; adverse effects to this potential resource will be temporary and minimal.

6.4.6.6 Wetlands

As mapped in the Barnegat Bay Ecosystem Restoration Environmental Testing and Restoration Proposals (Harriott and Southerland 2001), a total of approximately 48.55 acres of wetlands currently exist at the Flat Island site (in addition, 9.91 acres of SAV were mapped in the adjacent open waters of Barnegat Bay). A large proportion of Flat Island consists of dense, monotypic phragmites marsh. A total of 10.08 acres of nontidal phragmites marsh would be affected by the proposed action; it would be replaced by a system of shallow tidal open water channels with margins of tidal marsh dominated by cordgrasses. There will be no net loss of wetlands as a result of the project. Considering the fact that the existing phragmites marsh comprises relatively poor wildlife habitat, and that it would be replaced by more valuable habitat for a variety of native wildlife, overall adverse effects to existing vegetated wetlands are considered minimal.

6.4.6.7 Air Quality

In the short-term, employee vehicles and construction equipment will cause a temporary increase in emissions of volatile organic compounds, nitrogen oxides, sulfur dioxide, and carbon monoxide. Emissions produced during construction are not expected, however, to exceed ambient air quality standards for the area. No long-term impacts to local air quality are expected from the proposed action; therefore no adverse effects are anticipated.

6.4.6.8 Hazardous and Toxic Materials

Existing data base information (as well as site observations during the ecological field studies) suggests very little potential for encountering hazards on the Flat Island site. The data also indicate that there are no potential hazards on any directly adjacent properties (i.e., the Bay). All of the listed records are on Long Beach Island, and appear to be relatively minor and of no consequence relating to the proposed restoration actions. Therefore, no adverse effects relating to hazardous and toxic materials are anticipated as a result of the proposed action.

6.4.6.9 Water Resources

The existing surface water resources at the Flat Island site (several small ponds) are isolated, shallow, poorly-flushed, and likely possess poor quality habitat for wildlife. As a result of the proposed action, these water resources would be connected to the tidal waters of the Bay via a braided system of new channels with two outlets/inlets to the adjacent Bay. The braided channels will provide a large quantity of new, high-quality water resources. A variety of native wildlife currently use the existing high quality tidal marsh at the site; it is anticipated that these species and possibly others will be attracted to the new water resources and tidal marsh created under the proposed action. Therefore, no adverse effects relating to water resources are anticipated as a result of the proposed action.

6.4.6.10 Geology and Soils

All of the substrate to be excavated for creation of the proposed system of intertidal channels at the Flat Island site is dredged material; no native soils will be disturbed. Excavated materials will be placed on an upland area containing only dredged materials. No adverse effects relating to native geology and soils, therefore, are anticipated as a result of the proposed action.

6.4.6.11 Recreational Resources

No signs of recreational use by the public at the Flat Island site by boaters, swimmers, anglers, or wildlife watchers are currently apparent. Limited opportunity exists for wildlife watching on the existing tidal marsh; virtually no opportunity exists in the interior of the island, where tall, dense phragmites impedes foot travel and viewing. Other potential activities, such as wildlife viewing from canoes, kayaks, and small boats may be possible in the system of new channels, although access may be limited at low tide in many areas. No adverse effects to recreational resources are anticipated as a result of the proposed action.

6.4.6.12 Cultural Resources

A preliminary review of the information provided for this project area indicates a fairly low probability for the presence of archaeological sites. This project site is located in low lying area that has been subjected to flooding, erosion, and extensive previous construction activity. Consultation with the NJ SHPO is continuing and will be concluded prior to any construction activity.

Flat Island project area is low lying marsh area that has been used for the disposal of dredged material within the last 20 years (see site description in Section 3.6). Substrate corings taken throughout the project site and other measurements indicate that the depth of fill ranges from 2 to 11 feet above pre-disposal marsh deposits. The proposed excavation of a meandering and braided open channel system will be restricted to these fill deposits, which have no potential for significant cultural resources.

6.4.6.13 Socioeconomic Resources

No socioeconomic impacts are anticipated.

6.4.6.14 Aesthetic/Visual Resources

Creation of the new intertidal channel system will improve aesthetic/visual resources at the Flat Island site. The existing viewshed in the majority of the site is impeded by dense, tall phragmites. The habitats in the immediate vicinity of the new channels will comprise open water and tidal marsh; these new habitats should be much more aesthetically appealing than the existing phragmites marsh. The aesthetically pleasing views from the existing tidal marsh on the western part of the site would not be affected by the proposed action. No adverse effects to aesthetic/visual resources are anticipated as a result of the proposed action.

6.4.6.15 Cumulative Impacts

Cumulative impacts may arise when the effects of individual actions that are not significant combine with the effects of other past, present, or reasonably foreseeable future actions (regardless of who undertakes these actions) to produce significant effects on resources. Whether adverse cumulative impacts are significant depends on the magnitude and extent of the effects and the capacity of the resources to withstand these effects.

Under the proposed action, restoration activities at Flat Island will benefit the biological resources and ecological condition of the Barnegat Bay ecosystem. When combined with other actions in the vicinity, these activities will augment environmental improvements or, at a minimum, slow degradation effects. No activities associated with the proposed action will contribute to adverse cumulative impacts.

6.5 POST-CONSTRUCTION ENVIRONMENTAL MONITORING & COSTS

Monitoring will be conducted 1-3 years post-construction to determine if predicted outputs are achieved and to provide feedback for future ecosystem restoration projects. Per ER 1105-2-100 (22 April 2000), the monitoring plan will be designed to 1) be comparable to pre-construction data collection methodologies; 2) determine if the project is meeting its restoration objectives; and 3) evaluate the need for project adjustments for unforeseen circumstances should the need to modify structures, operation, or management be required (adaptive management).

Monitoring proposed for each of the following six proposed project sites will include methodologies utilized by Versar, Inc.(for USACE) to evaluate the sites for conceptual plans early in the planning process in *Barnegat Bay Ecosystem Restoration Environmental Testing and Restoration Proposals* (Harriott and Southerland, 2001) and *Environmental Restoration of Dredged Hole #6, Barnegat Bay, New Jersey* (USACE, 2002).

6.5.1 F & L Abandoned Lagoons

The primary restoration goal for this project is to enhance circulation and provide shallow water depths to improve water quality in these lagoons, thereby improving juvenile fish habitat. The secondary goal is to create islands and improve diamondback terrapin habitat. A simplified bathymetric survey will be performed to assess depths, bottom contours, and substrate at multiple stations evenly distributed throughout the lagoon. Within the first three years post-construction, fish populations will be assessed annually using seine and gill nets. Juvenile fish will be sampled during the summer using seine nets in the shallow shelves of the southeastern end of the western branch, at the southwestern end of the eastern branch, and on the northern side of the entrance to the lagoon. Gillnetting may be deployed to determine if adult fish are utilizing the site. Surface water quality should be evaluated at several depths in several locations for salinity, dissolved oxygen, and other indicator parameters. Within the first three years following construction, signs of wildlife, species and percent coverage of vegetation (upland deciduous forest, wetland/salt marsh, phragmites and percent exposed sandy areas) will be quantified. Field observations shall be made during the summer months for mammalian, avian, and reptilian species, not only for individuals, but also signs of wildlife such as tracks, scats, calls, and other identifiable physical evidence. The total anticipated monitoring cost is anticipated to be $11,160. Actual monitoring costs may vary. Per ER 1105-2-100, 22 April 2000, the cost of monitoring should normally not exceed one percent of the first cost of the ecosystem restoration feature(s).

6.5.2 Bayville Lagoon

The restoration goals for this project are to induce tidal circulation and provide shallow water depths to improve water quality in the lagoon, thereby improving juvenile fish habitat (primary goal), creating additional submerged aquatic vegetation (secondary goal) and restoring tidal marsh (tertiary goal). A simplified bathymetric survey will be performed to assess depths, bottom contours, and substrate at multiple stations evenly distributed throughout the lagoon. Within the first three years post-construction, fish populations will be assessed annually using seine and gill nets. Juvenile fish will be sampled during the summer using seine nets in the

shallow shelves of the lagoon. Gillnetting may be deployed to determine if adult fish are utilizing the site. Surface water quality should be evaluated at several depths in several locations for salinity, dissolved oxygen, and other indicator parameters. Within the first three years following construction, signs of wildlife, species and percent coverage of vegetation (upland deciduous forest, wetland/salt marsh, phragmites and percent exposed sandy areas) will be quantified. Field observations shall be made during the summer months for mammalian, avian, and reptilian species, not only for individuals, but also signs of wildlife such as tracks, scats, calls, and other identifiable physical evidence. The total anticipated monitoring cost is anticipated to be $9,583. Actual monitoring costs may vary. Per ER 1105-2-100, 22 April 2000, the cost of monitoring should normally not exceed one percent of the first cost of the ecosystem restoration feature(s).

6.5.3 Oyster Creek

The restoration goals of this project are to improve habitat for marsh wren, seaside sparrow, sharp-tailed sparrows, willet and the like and to improve habitat for diamondback terrapin in the open sand area at the western end. This will be achieved by re-introducing tidal flow of saline water from Oyster Creek and depositing the excavated material at an existing sandy upland area. Post-construction monitoring should occur during the summer months and include field observations for wildlife and their signs (tracks, scats, calls, and other identifiable physical evidence). The site should also be assessed for vegetation and land cover to assess whether re-introduced tidal flow has improved the native tidal marsh vegetation and habitat for the first 3 years post-construction. The total anticipated monitoring cost is anticipated to be $22,110. Actual monitoring costs may vary. Per ER 1105-2-100, 22 April 2000, the cost of monitoring should normally not exceed one percent of the first cost of the ecosystem restoration feature(s).

6.5.4 Barnegat Lighthouse

The restoration objective of this site is to improve existing habitats for piping plover (*Charadruis melodus*), a Federal threatened and endangered bird. The site should be monitored for the first three years post-construction during the summer months for wildlife and their signs (tracks, scats, calls and other identifiable physical evidence), particularly for shorebird and predatory species. Vegetation and land cover of saltmarsh and beach plant species, phragmites, and percent exposed sandy areas will be quantified. The constructed pond should be sampled for the first 2 years to determine the establishment of intertidal benthic species and the quality of forage food value introduced to the site. The total anticipated monitoring cost is anticipated to be $22,572. Actual monitoring costs may vary. Per ER 1105-2-100, 22 April 2000, the cost of monitoring should normally not exceed one percent of the first cost of the ecosystem restoration feature(s).

6.5.5 Stafford Forge

The restoration goals for this project are to create habitat for alewife and blueback herring, and to improve habitat for waterfowl. The site should be monitored for 3 years post-construction for surface water quality at several locations, such as pH, dissolved oxygen, temperature, and flow. The site should also be assessed for vegetation and land cover. The site will also be assessed for

fisheries for the first three years post-construction. Gill netting annually will be required once the fish ladders are in place and if necessary, "seeding" of hatchery fish stock to assess establishment of an anadromous population. The site should be surveyed for wildlife, particularly for waterfowl through physical evidence. The total anticipated monitoring cost is anticipated to be $4,807. Actual monitoring costs may vary. Per ER 1105-2-100, 22 April 2000, the cost of monitoring should normally not exceed one percent of the first cost of the ecosystem restoration feature(s).

6.5.6 Flat Island

The restoration goals for this site are to improve habitat for marsh wren, seaside sparrow, sharp-tailed sparrow, willet and the like, and to prevent re-growth of phragmites. The eastern and northeastern portions of the island are to be reserved as a dredged material placement site. The primary vegetation type is currently phragmites. Approximately 7.7 acres of tidal marsh will be re-established. Phragmites control should be assessed annually during the first three years of eradication to determine success. The site should also be assessed for vegetation and land cover to assess whether re-introduced tidal flow has improved the native tidal marsh vegetation and habitat for the first 3 years post-construction. The total anticipated monitoring cost is anticipated to be $22,636. Actual monitoring costs may vary. Per ER 1105-2-100, 22 April 2000, the cost of monitoring should normally not exceed one percent of the first cost of the ecosystem restoration feature(s).

6.6 PROJECT COST ESTIMATE

6.6.1 Real Estate

Perpetual conservation easements will be required for the construction, operation, and maintenance of the environmental components on each project area, except as noted below. Temporary work area easements will be required for staging areas, excavated material deposit areas, and haul roads. Perpetual road easements will be required at some sites to ensure future O&M access. One fee estate is required for the bridges over the channels at Barnegat Lighthouse. Since the F&L Abandoned Lagoon site is Federally owned and managed by the USFWS, only a Special Use Permit will be required for the completion of the environmental restoration. No estate acquisition will be required for this site. Ownership information, acreage amounts, and cost information for all sites are summarized in Table 6-1. Individual real estate plans are included in Appendix G.

6.6.2 First Costs

The estimated first cost for the selected plans described above are presented in Table 6-2 and includes real estate acquisition costs (including administrative costs), engineering and design (E&D), construction management (S&A) and associated contingencies (15%). E&D costs include preparation of plans and specifications, project management, environmental coordination, value engineering, execution of the PCA and monitoring during construction.

6.6.3 Operation, Maintenance, Repair, Replacement, and Rehabilitation

The annual Operation, Maintenance, Repair, Replacement, and Rehabilitation (OMRR&R) of the projects includes maintaining the tidal connections (open channels and culverts) established to restore tidal flow into the project areas. Other operation and maintenance costs pertain to routine maintenance of the water control structures. Average annual costs for these items for the selected plans are presented in Table 6-3.

6.6.4 Interest During Construction

Table 6-3 presents the estimated interest during construction for each of the selected plans. It is assumed that the construction costs would be evenly distributed over the construction period. The duration of initial construction for the projects varies from 4 months to 9 months.

6.6.5 Project Monitoring During Construction

Construction inspectors will be present on-site during construction in order to assure adherence to project plans and specifications.

6.6.6 Total Estimated Annualized Cost

The estimated total annualized costs of the selected plans are presented in Table 6-3 and are based on an economic life of 25 years (except for Barnegat Lighthouse which has a life of 10 years) and a discount rate of 6.125 percent. These costs include the annualized first cost, interest during construction and OMRR&R.

Table 6-1

Real Estate Summary Chart

Site	Current Ownership		Recommended RE Acquisition					Costs		Total Costs
	Type	Owner	Fee	Easement	TWAE	Permit	Total Acres	Land Payment	Admin	
Barnegat Lighthouse	Public	NJDEP, Division of Parks and Forestry	0.03	9.7	3.9		13.6	$2,990.00	$6,797.00	$9,787.00
Bayville Abandoned Lagoon	Public	Ocean County Natural Land Trust		11.45	0.5		11.95	$2,013.00	$13,282.00	$15,295.00
F&L Abandoned Lagoons	Public	United State of America, US Fish and Wildlife Service				22.6	22.6	$0.00	$7,015.00	$7,015.00
Flat Island	Private	Flat Islands Investors Corp.		11.62	14.79		26.41	$55,545.00	$7,878.00	$63,423.00
Oyster Creek	Private	AmerGen Energy Company LLC		51.9	5.87		57.77	$50,500.00	$9,430.00	$59,930.00
Stafford Forge	Public	NJDEP, Division of Fish and Wildlife		2.5	2		4.5	$920.00	$7,130.00	$8,050.00
TOTALS:			0.03	87.17	27.06	22.6	136.83	$111,968.00	$51,532.00	$163,500.00

Table 6-2

TOTAL ESTIMATED FIRST COSTS

(SEPTEMBER 2002 PRICE LEVEL)

Selected Plans	Implementation Costs			Construction Management	Total First Costs
	Lands and Damages	Fish & Wildlife Facilities	Planning, Engineering & Design		
F&L Abandoned Lagoons (Alt. 3)	$7,000	$784,100	$223,700	$101,200	$1,116,000
Bayville Abandoned Lagoon (Alt. 4)	$15,300	$623,900	$217,900	$101,200	$958,300
Oyster Creek (Alt. 3)	$59,900	$1,703,100	$272,000	$176,000	$2,211,000
Barnegat Lighthouse (Alt. 4A)	$9,800	$1,791,400	$272,000	$184,000	$2,257,200
Stafford Forge (Alt. 7)	$8,100	$200,000	$171,400	$101,200	$480,700
Flat Island (Alt. 3)	$63,400	$1,747,600	$272,000	$180,600	$2,263,600

Table 6-3

TOTAL ESTIMATED ANNUALIZED COSTS

(SEPTEMBER 2002 PRICE LEVEL)

Selected Plans	Implementation Costs			OMRR&R Costs	Total Average Annual Costs
	Total First Cost	Interest During Construction	Average Annual Equivalent Cost*		
F&L Abandoned Lagoons (Alt. 3)	$1,116,000	$14,100	$89,500	$0	$89,500
Bayville Abandoned Lagoon (Alt. 4)	$958,300	$14,400	$77,000	$2,800	$79,800
Oyster Creek (Alt. 3)	$2,211,000	$33,200	$177,600	$3,200	$180,800
Barnegat Lighthouse (Alt. 4A)	$2,257,200	$33,900	$313,100	$2,800	$315,900
Stafford Forge (Alt. 7)	$480,700	$7,200	$38,600	$500	$39,100
Flat Island (Alt. 3)	$2,263,600	$34,000	$181,900	$3,200	$185,100

* 25 years at 6.125 percent (except Barnegat Lighthouse which has a life of 10 years.)

7.0 LOCAL COOPERATION

7.1 COST ALLOCATION AND APPORTIONMENT

A non-Federal sponsor is required to provide at least 35 percent of the implementation costs of the construction of these projects. Tables 7-1 through 7-6 show the cost sharing for the selected plans. Table 7-7 provides the cost sharing for all of the projects as a whole.

Table 7-1

F & L Abandoned Lagoons

Cost Sharing for Selected Plan

Item			Cost		
Construction Costs			$1,108,974		
Lands, Easements, Rights-of Way, Relocations, Disposal Areas (LERRD) Costs			$7,015		
Project Feature	Federal Cost	%	Non-Federal Cost	%	Total Cost
Initial Project Costs	$725,393	65	$390,596	35	$1,115,989
Monitoring Costs*	$7,254	65	$3,906	35	$11,160
Total Costs	$732,647	65	$394,502	35	$1,127,149
LERRD Credit			$7,015		$7,015
Final Cash Contribution	$732,647		$387,487		$1,120,134

Table 7-2

Bayville Abandoned Lagoon

Cost Sharing for Selected Plan

Item			Cost		
Construction Costs			$943,015		
Lands, Easements, Rights-of Way, Relocations, Disposal Areas (LERRD) Costs			$15,295		
Project Feature	Federal Cost	%	Non-Federal Cost	%	Total Cost
Initial Project Costs	$622,902	65	$335,408	35	$958,310
Monitoring Costs*	$6,229	65	$3,354	35	$9,583
Total Costs	$629,131	65	$338,762	35	$967,893
LERRD Credit			$15,295		$15,295
Final Cash Contribution	$629,131		$323,467		$952,598

Table 7-3

Oyster Creek

Cost Sharing for Selected Plan

Item			Cost		
Construction Costs			$2,151,022		
Lands, Easements, Rights-of Way, Relocations, Disposal Areas (LERRD) Costs			$59,930		
Project Feature	Federal Cost	%	Non-Federal Cost	%	Total Cost
Initial Project Costs	$1,437,119	65	$773,833	35	$2,210,952
Monitoring Costs*	$14,372	65	$7,738	35	$22,110
Total Costs	$1,451,491		$781,571		$2,233,062
LERRD Credit			$59,930		$59,930
Final Cash Contribution	$1,451,491		$721,641		$2,173,132

Table 7-4

Barnegat Lighthouse

Cost Sharing for Selected Plan

Item			Cost		
Construction Costs			$2,247,386		
Lands, Easements, Rights-of Way, Relocations, Disposal Areas (LERRD) Costs			$9,787		
Project Feature	Federal Cost	%	Non-Federal Cost	%	Total Cost
Initial Project Costs	$1,467,162	65	$790,011	35	$2,257,173
Monitoring Costs*	$14,672	65	$7,900	35	$22,572
Total Costs	$1,481,834		$797,911		$2,279,745
LERRD Credit			$9,787		$9,787
Final Cash Contribution	$1,481,834		$788,124		$2,269,958

Table 7-5

Stafford Forge

Cost Sharing for Selected Plan

Item			Cost		
Construction Costs			$472,612		
Lands, Easements, Rights-of Way, Relocations, Disposal Areas (LERRD)			$8,050		
Project Feature	Federal Cost	%	Non-Federal Cost	%	Total Cost
Initial Project Costs	$312,430	65	$168,232	35	$480,662
Monitoring Costs*	$3,125	65	$1,682	35	$4,807
Archeological Salvage**	$20,000				$20,000
Total Costs	$335,555		$169,914		$505,469
LERRD Credit			$8,050		$8,050
Final Cash Contribution	$335,555		$161,864		$497,419

Table 7-6

Flat Island

Cost Sharing for Selected Plan

Item			Cost		
Construction Costs			$2,200,132		
Lands, Easements, Rights-of Way, Relocations, Disposal Areas (LERRD) Costs			$63,423		
Project Feature	Federal Cost	%	Non-Federal Cost	%	Total Cost
Initial Project Costs	$1,471,311	65	$792,244	35	$2,263,555
Monitoring Costs*	$14,713	65	$7,923	35	$22,636
Total Costs	$1,486,024		$800,167		$2,286,191
LERRD Credit			$63,423		$63,423
Final Cash Contribution	$1,486,024		$736,744		$2,222,768

Table 7-7

Total

Cost Sharing for Selected Plans

Item			Cost		
Construction Costs			$9,123,141		
Lands, Easements, Rights-of Way, Relocations, Disposal Areas (LERRD) Costs			$163,500		
Project Feature	Federal Cost	%	Non-Federal Cost	%	Total Cost
Initial Project Costs	$6,036,317	65	$3,250,324	35	$9,286,641
Monitoring Costs*	$60,365	65	$32,503	35	$92,868
Archeological Salvage**	$20,000				$20,000
Total Costs	$6,116,682		$3,282,827		$9,399,509
LERRD Credit			$163,500		$163,500
Final Cash Contribution	$6,116,682		$3,119,327		$9,236,009

* Actual monitoring costs may vary. Per ER 1105-2-100, 22 April 2000, the cost of monitoring included in the total project cost and cost shared with the non-Federal sponsor should normally not exceed one percent of the first cost of the ecosystem restoration feature(s).

** Actual cost may vary.

7.1.1 Financial Analysis

Per a January 22, 2003 letter from the non-Federal sponsor, NJDEP, to USACE, the projects described in this report have the support of NJDEP. However, State matching funds for these projects cannot be identified at the present time. As soon as funds can be identified, NJDEP will notify USACE of NJDEP's intent to proceed and enter into a Planning, Engineering and Design agreement with USACE. It is likely that NJDEP will want to pursue each of the projects independently.

7.2 PROJECT COOPERATION AGREEMENT

Section 221 of Public Law 91-611, Flood Control Act of 1970, as amended, and Section 103 of the Water Resources Development Act of 1986, Public Law 99-662, as amended, require that the Secretary of the Army shall not commence the construction of any water resources project or separable element thereof, until the non-Federal sponsor has entered into a written agreement to furnish its required cooperation for the project or separable element.

Depending on non-Federal sponsorship and authorization used for construction, one or more fully coordinated PCA packages (to include the Sponsor's financing plan) will be prepared subsequent to the approval of the feasibility phase and will reflect the recommendations of this Feasibility Report.

7.2.1 Non-Federal Responsibilities

Should Congress appropriate funds for construction of the projects, the non-Federal sponsor(s) would have to assume non-Federal responsibilities subject to cost sharing, financing, and other applicable requirements of the Water Resources Development Acts of 1986 and 1996, including those indicated in the following paragraphs:

7.2.1.1 Non-Federal Costs & In-kind Services

Provide 35 percent of the total project costs assigned to environmental restoration as further specified below. Per ER 1165-2-501, 30 September 1999, if construction is conducted as a Congressionally authorized project, no work in-kind is eligible for meeting the non-Federal cost share requirement. If construction is conducted under Section 206 of WRDA 1996, the entire non-Federal sponsor's share may be work-in-kind, including plans and specifications, materials, and project construction.

Per Section 203 of WRDA 92, voluntary contributions of cash, funds, materials, and services may be accepted from sources other than the project sponsor, including governmental entities, however, such voluntary contributions are to be applied toward total project costs to reduce both Federal and sponsor shares.

7.2.1.2 Operation, Maintenance, Repair, Replacement and Rehabilitation

The local sponsor must operate, maintain, repair, replace, and rehabilitate the completed project, or functional portion of the project, at no cost to the Federal Government, in a manner compatible with the project's authorized purposes and in accordance with applicable Federal and State laws and regulations and any specific directions prescribed by the Federal Government.

7.2.1.3 Hold and Save Clause

Hold and save the United Stated free from all damages arising from the construction, operation, maintenance, repair, replacement, and rehabilitation of the project and any project-related betterments, except for damages due to the fault or negligence of the United States or its contractors.

7.2.1.4 Documentation

Keep and maintain books, records, documents, and other evidence pertaining to costs and expenses incurred pursuant to the project in accordance with the standards for financial management systems set forth in the Uniform Administrative Requirements for Grants and Cooperative Agreements to State and Local Governments at 32 Code of Federal Regulations (CFR) Section 33.20.

7.2.1.5 Investigation of Hazardous Substances

The local sponsor would perform, or cause to be performed, any investigations for hazardous substances that are determined necessary to identify the existence and extent of any hazardous substances regulated under CERCLA, Public Law 96-510, as amended, 42 U.S.C. 9601-9675, that may exist in, on, or under lands, easements, or rights-of-way that the Federal Government determines to be required for the construction, operation, and maintenance of the project. For any lands that the Federal Government determines to be subject to navigation servitude, only the Federal Government shall perform such investigations unless the Federal Government provides the non-Federal Sponsor with prior specific written directions, in which case the non-Federal Sponsor shall perform such investigations in accordance with such written direction.

7.2.1.6 Cleanup of Hazardous Substances

Assume complete financial responsibility for all necessary cleanup and response costs of any CERCLA regulated materials located in, on, or under lands, easements, or rights-of-way that the Federal Government determines to be necessary for the construction, operation, or maintenance of the project.

7.2.1.7 Liability for Hazardous Substances

Agree that the non-Federal Sponsor shall be considered the operator of the project for the purpose of CERCLA liability, and to the maximum extent practicable, operate, maintain, and repair the project in a manner that will not cause liability to arise under CERCLA.

7.2.1.8 Federal Real Estate Requirements

Comply with the provisions of the Uniform Relocation Assistance and Real Property Acquisition Policies Act of 1970, Public Law 91-646, as amended by Title IV of the Surface Transportation and Uniform Relocation Assistance Act of 1987 (Public Law 100-17), and the Uniform Regulations contained in 49 CFR Part 24, in acquiring lands, easements, and rights-of-way, required for the construction, operation, and maintenance of the project, including those necessary for relocations, borrow materials, and dredged or excavated material disposal, and inform all affected persons of applicable benefits, policies, and procedures in connection with said Act.

7.2.1.9 State and Federal Regulations

Comply with all applicable Federal and State laws and regulations, including, but not limited to, Section 601 of the Civil Rights Act of 1964, Public Law 88-352 (42 U.S.C. 2000d), and Department of Defense Directive 5500.11 issued pursuant thereto, as well as Army Regulation 600-7, entitled "Nondiscrimination on the Basis of Handicap in Programs and Activities Assisted or Conducted by the Department of the Army.

7.2.1.10 Public Ownership

For so long as the project remains authorized, the non-Federal Sponsor shall ensure continued conditions of public ownership upon which Federal participation is based.

7.2.1.11 Assurance of Project Integrity

Prescribe and enforce regulations to prevent obstruction of or encroachment on the Project by structures or persons that would reduce the level of ecosystem restoration and protection it affords or that would hinder operation or maintenance of the Project.

7.2.1.12 Use of Federal Funds

Do not use Federal funds to meet the non-Federal sponsor's share of total project costs unless the Federal granting agency verifies in writing that the expenditure of such funds is expressly authorized by statute.

8.0 CONCLUSIONS AND RECOMMENDATIONS

8.1 CONCLUSIONS

Barnegat Bay, a 75mi^2 ecosystem, is an environmentally sensitive estuary, replete with benthic organisms, fishery habitat, waterfowl nesting grounds, and aquatic vegetation. Over time the surrounding area has become increasingly suburbanized and human activities have had a deleterious impact on the ecosystem. In 1995 Barnegat Bay was recognized by USEPA as an estuary of national significance and the Barnegat Bay Estuary Program was formed. The resulting Comprehensive Conservation and Management Plan includes USACE and NJDEP's commitment to study the feasibility of ecosystem restoration in the Bay and adjacent lands. Based on coordination with NJDEP, the following selected ecosystem restoration plans, with the exception of Bayville Lagoon (where no action is recommended), would be pursued most expeditiously under USACE's Continuing Authorities Program.

- F&L Abandoned Lagoon - Provide a total of 8.45 acres of fish and benthic habitat and 3.27 acres of diamondback terrapin habitat. Accomplish this through a combination of decreasing existing lagoon depths to an average of 6 feet, improving water quality (by improving circulation and decreasing depth), and flattening/clearing existing sandy piles (for terrapin habitat). Circulation will be improved by excavating a 270-foot long channel of approximately 400 square feet in cross sectional area between the ends of the two prongs of F Lagoon, and two 200-foot long channels of approximately 400 square feet in cross sectional area between the ends of the two prongs of F Lagoon and L Lagoon. However, because the site is owned by a Federal agency (USFWS), USACE would need to demonstrate consistency with USACE ER 1105-2-100, Planning Guidance Notebook, Appendix F, b.1 prior to approval for construction.

- Bayville Abandoned Lagoon – Planning activities prior to December 19, 2002 indicate that the selected plan involves providing a total of 4.79 acres of fish and benthic and black duck habitat. Accomplish this through a combination of decreasing existing lagoon depths to an average of 6 feet and improving water quality (by improving circulation and decreasing depth). Circulation will be improved by excavation of an approximately 500-foot long channel with 300 square feet in cross section area meandering through the phragmites and tidal marsh areas between the west end of the lagoon and the Bay; installation of up to three 64"x43" elliptical concrete or aluminum corrugated metal arch (CMPA) culvert pipes with end sections, 50-foot long each across the road, and a 250-foot long open channel with 70 square feet of cross sectional area below MLW and up to 130 square feet above MLW through a short segment of the upland forest and predominantly phragmites area further to the east end of the Lagoon and into the Bay. However, per request made by the landowner, the County of Ocean, on December 19, 2002, USACE recommends that work at this project site not be pursued beyond the feasibility phase.

- Oyster Creek – Provide a total of 18.31 acres of salt marsh for birds and 10.14 acres of diamondback terrapin habitat. Accomplish this through excavation of a meandering and

braided open channel system of approximately 35 feet in width at MLW and 9,400 feet in length, connected to the Bay at the east and in the south through 100-foot wide openings provided through the existing timber bulkhead.

- Barnegat Lighthouse – Provide 6.72 acres of piping plover habitat. Accomplish this through excavation of a pond with a surface area of approximately 5 acres measured at MHW with access to tidal water landward of the Barnegat Inlet south jetty by means of two inlets formed by two open channels.

- Stafford Forge – Provide 70.86 acres of black duck habitat and 113.57 acres of on-site habitat for anadromous fish. In addition, approximately 10.2 stream miles will be made available to fish above the site. Accomplish this by adding a fish ladder to an existing water control structure, refurbishing existing culvert and water control structures, and installing new water control structures.

- Flat Island – Provide 10.08 acres of salt marsh habitat for birds. Accomplish this by excavating a meandering and braided open channel system throughout a portion of the western side of the island. The channel system will be approximately 10,000 feet in length with the average cross-section including 70 square feet below MLW and 130 square feet above MLW.

8.1.1 Project Benefits

EP 1165-2-502 states that "Rather than limiting objectives to habitat for a single species or resource commodity, such as mallard ducks or bass harvest, ecosystem restoration initiatives will consider interrelationships of plant and animal communities and their habitats in a larger ecosystem context." It also states that "Single species habitat models may be limiting if used to optimize for a particular species, but they can be useful when carefully applied in the ecosystem context in which the habitat is situated." Therefore, a total of eight species or suites of species (including songbirds, waterfowl, shorebirds, migratory fish, terrapin, and benthic invertebrate communities) were selected to represent the restoration benefits at each of the six project sites. Implicit in this ecosystem approach is the fact that the benefits resulting from the proposed restorations will not be limited to these selected species. Other species will benefit and, in addition, many ecosystem-level benefits, such as improvement of Barnegat Bay water quality, increased connectivity of native habitats, and more natural ecological processes (e.g., hydrology and nutrient cycling), would also result from the proposed restorations. Therefore, the following information on acres restored should be understood to be representative of broader benefits.

8.1.1.1 F&L Lagoons

The selected plan would restore 8.45 acres of fish of fish and benthic habitat and 3.27 acres of diamondback terrapin habitat.

8.1.1.2 Bayville Abandoned Lagoon

Planning activities prior to December 19, 2002 indicate that the selected plan will restore 4.79 acres of fish, benthic and black duck habitat.

8.1.1.3 Oyster Creek
The selected plan will restore 10.14 acres of diamondback terrapin habitat and 18.31 acres of new tidal marsh habitat for songbirds.

8.1.1.4 Barnegat Lighthouse
The selected plan will restore 6.72 acres of habitat for piping plover.

8.1.1.5 Stafford Forge
The selected plan will restore 70.86 acres of habitat for black duck and 113.57 acres of on-site anadromous fish habitat. In addition, approximately 10.2 stream miles will be made available to fish upstream from the project site.

8.1.1.6 Flat Island
The selected plan will restore 10.08 acres of tidal marsh habitat for a suite of songbirds.

8.1.2 Initial Project Costs
Refer to Section 7.1 for further information on cost allocation and apportionment.

8.1.2.1 F&L Abandoned Lagoons
Based on January 2002 price levels, the total project cost is estimated to be $1,115,989. The Federal share of this cost is $725,393 and the non-Federal share is $390,596. Lands, Easements, Rights-of-Ways, Relocations and Dredged Material Disposal Areas (LERRD) costs are $7,015 and will be credited toward the non-Federal sponsor's cash contribution.

8.1.2.2 Bayville Abandoned Lagoon
Planning activities prior to December 19, 2002 indicate that based on January 2002 price levels, the total project cost is estimated to be $958,310. The Federal share of this cost is $622,902 and the non-Federal share is $335,408. LERRD costs are $15,295 and will be credited toward the non-Federal sponsor's cash contribution.

8.1.2.3 Oyster Creek
Based on January 2002 price levels, the total project cost is estimated to be $2,210,952. The Federal share of this cost is $1,437,119 and the non-Federal share is $773,833. LERRD costs are $59,930 and will be credited toward the non-Federal sponsor's cash contribution.

8.1.2.4 Barnegat Lighthouse
Based on January 2002 price levels, the total project cost is estimated to be $2,257,173. The Federal share of this cost is $1,467,162 and the non-Federal share is $790,011. LERRD costs are $9,787 and will be credited toward the non-Federal sponsor's cash contribution.

8.1.2.5 Stafford Forge
Based on January 2002 price levels, the total project cost is estimated to be $480,662. The Federal share of this cost is $312,430 and the non-Federal share is $168,232. LERRD costs are $8,050 and will be credited toward the non-Federal sponsor's cash contribution.

8.1.2.6 Flat Island

Based on January 2002 price levels, the total project cost is estimated to be $2,263,555. The Federal share of this cost is $1,471,311 and the non-Federal share is $792,244. LERRD costs are $63,423 and will be credited toward the non-Federal sponsor's cash contribution.

8.1.2.7 Total of All Projects

Based on January 2002 price levels, the total project cost is estimated to be $9,286,641. The Federal share of this cost is $6,036,317 and the non-Federal share is $3,250,324. LERRD costs are $163,500 and will be credited toward the non-Federal sponsor's cash contribution.

8.1.3 Ultimate Project Costs

8.1.3.1 F&L Abandoned Lagoon

The ultimate cost of construction which includes initial construction and project monitoring is estimated to be $1,127,149, cost shared 65% Federal, 35% non-Federal. All costs also include planning, engineering, and design. Operation, Maintenance, Repair, Replacement, and Rehabilitation (OMRR&R) is a non-Federal responsibility.

8.1.3.2 Bayville Abandoned Lagoon

Planning activities prior to December 19, 2002 indicate that the ultimate cost of construction which includes initial construction and project monitoring is estimated to be $967,893, cost shared 65% Federal, 35% non-Federal. All costs also include planning, engineering, and design. OMRR&R is a non-Federal responsibility.

8.1.3.3 Oyster Creek

The ultimate cost of construction which includes initial construction and project monitoring is estimated to be $2,233,062, cost shared 65% Federal, 35% non-Federal. All costs also include planning, engineering, and design. OMRR&R is a non-Federal responsibility.

8.1.3.4 Barnegat Lighthouse

The ultimate cost of construction which includes initial construction and project monitoring is estimated to be $2,279,745, cost shared 65% Federal, 35% non-Federal. All costs also include planning, engineering, and design. OMRR&R is a non-Federal responsibility.

8.1.3.5 Stafford Forge

The ultimate cost of construction which includes initial construction, archeological salvage and project monitoring is estimated to be $505,469, cost shared 65% Federal, 35% non-Federal. All costs also include planning, engineering, and design. OMRR&R is a non-Federal responsibility.

8.1.3.6 Flat Island

The ultimate cost of construction which includes initial construction and project monitoring is estimated to be $2,286,191, cost shared 65% Federal, 35% non-Federal. All costs also include planning, engineering, and design. OMRR&R is a non-Federal responsibility.

8.1.3.7 Total of All Projects

The ultimate cost of construction which includes initial construction, archeological salvage and project monitoring is estimated to be $9,399,509, cost shared 65% Federal, 35% non-Federal. All costs also include planning, engineering, and design. OMRR&R is a non-Federal responsibility.

8.2 RECOMMENDATIONS

In making the following recommendations, I have given consideration to all significant aspects in the overall public interest including environmental (incorporating USACE Environmental Operating Principles), social and economic effects, engineering feasibility and compatibility of the project with policies, desires, and capabilities of the State of New Jersey and other non-Federal interests.

I recommend that the selected plans for the Barnegat Bay Ecosystem Restoration project, as fully detailed in this integrated feasibility report and environmental impact assessment, can best be pursued under the Continuing Authorities Program. Accordingly, I recommend no further action under the General Investigation Program.

_____ _____

Date

Thomas C. Chapman, P.E.
Lieutenant Colonel, Corps of Engineers
District Engineer